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EDITORIAL ANNOUNCEMENTS.

THE BRITISH AND EASTERN CONTINENTS edition of the Railroad Gazette is published each Friday at Queen Anne's Chambers, Westminster, London. It contains selected reading pages from the Railroad Gazette, together with additional British and foreign matter, and is issued under the name Railway Gazette.

CONTRIBUTIONS.—Subscribers and others will materially assist in making our news accurate and complete if they will send early information of events which take place under their observation. Discussions of subjects pertaining to all departments of railroad business by men practically acquainted with them are especially desired.

ADVERTISEMENTS.—We wish it distinctly understood that we will entertain no proposition to publish anything in this journal for pay, EXCEPT IN THE ADVERTISING COLUMNS. *We give in our editorial columns* OUR OWN *opinions, and these only, and in our news columns present only such matter as we consider interesting and important to our readers. Those who wish to recommend their inventions, machinery, supplies, financial schemes, etc., to our readers, can do so fully in our advertising columns, but it is useless to ask us to recommend them editorially, either for money or in consideration of advertising patronage.*

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VOL. XLII., No. 23. FRIDAY, JUNE 7, 1907.

The De Glehn compound locomotive illustrated on another page, built throughout to the metric scale, is a notable example of locomotive building in this country, and goes far to prove that the metric system is not as black as it has been painted, even for American mechanics. Of course, such a piece of work involved a good deal of special preparation in the way of gages and templates, but this evidently was not of such a character as to be prohibitive. As for the engine itself, it is of characteristically French design, and as such will probably not appeal to American engineers as a model to be copied. The coupling of connecting rods to two pairs of wheels, and the necessary displacement of the high-pressure cylinders, adds an air of complication which is always objectionable in this country, besides obstructing the means of access to the machinery that is located between the frames. These may sound like puerile objections to those who are using the engine, but they exist and are potent here. As usual in the French design, the machine has an air of elegance of finish and lightness of detail that is very pleasing to the eye and gives an idea of a high grade of efficiency.

Through the courtesy of one of the large locomotive works in this country, we have been able to publish in another column some exact figures regarding the cost of modern locomotives in comparison with those of 1890. These figures are worth close attention, for they are of a nature not usually available for publication. The most striking point about the figures is that a modern locomotive costs less per pound than an up-to-date engine of 1890. This is in spite of an increase in the cost of materials, and in spite of the growth in efficiency and complexity of the modern machine. When the increase in efficiency is taken into consideration, the first cost per unit of power is found to be reduced from 17 to 27 per cent., and the cost of operation per unit of power reduced from 20 to 30 per cent. In addition to this reduction in cost, the railroads of to-day have the advantage of a more highly developed equipment than was obtainable in 1890. A large number of locomotives carry electric headlights, the brake appliances have been largely improved and added to, and in many ways the purchaser is given increased convenience and safety, while the price has been reduced. Of course, in comparing prices of new engines with the prices given in our article, it must be borne in mind that there is no standard specification for locomotives, and that the prices we give are merely the averages of a considerable number of actual selling prices for each class of locomotive considered. In any individual case, it is possible to introduce changes of design or of details, which will make the price vary 10 to 15 per cent. either way from the average. The average prices, however, where based on a sufficient number of engines, form a fair criterion of the tendency of the prices in the period under consideration.

Gasolene motor cars have been entirely successful on the Union Pacific if we may judge from the paper read at the April meeting of the New York Railroad Club by W. R. McKeen, Jr., Superintendent of Motive Power of that road, which is reprinted elsewhere in this issue. Mr. McKeen is privileged to be enthusiastic about the experiment because he is the father of the idea and the inventor of the machinery used under the cars; but in the light of other published data he makes out somewhat too good a case for his hobby. About two years ago a committee of motive power officers of the Rock Island lines investigated the subject of self-propelled motor cars and in their report gave some estimated figures of cost of fuel and wages for five different types of cars, four of them steam cars. These figures reduced to the same comparative basis as those given by Mr. McKeen are as follows:

Type of car.	Daily—Cost of fuel.	Daily—Cost of wages.	Total cost, wages and fuel.*
Gasolene	$7.50	$7.00	$14.50.
Steam, simple; oil fuel.....	4.90	9.25	14.15.
Steam, compound; superhtr; oil	3.66	9.25	12.91
Steam, simple; coal fuel.....	2.69	9.25	11.94
Steam, compound; suprhtr; coal	2.01	9.25	11.26

*Per 100 miles run daily.

Mr. McKeen gives the total operating expense for a 100-h.p. car running 100 miles a day as varying under different conditions between $10 and $20, the average probably being about $18. This includes fuel, wages, running and shop repairs, lubricating oil, cleaning, etc. Just what proportion is charged to repairs is not stated but it is safe to conclude two things; first, that the motorman, who is a high-priced expert mechanic, spends a good deal of time, although perhaps not much money, in adjusting and otherwise tinkering with the machinery; second, that the real cost of heavy and light repairs has not yet been learned, for the cars have been in service hardly more than two years. Every automobile owner knows that heavy repairs begin some time and keep up for an indefinite time. At any rate the difference between $11.26, the lowest

cost of the steam motor cars, and $18, is more than enough to offset any difference in the cost of repairs, oil and cleaning. This is not intended as a criticism of the gasolene car as such, but to show the possibilities of the steam motor car when developed to as great a degree and as carefully designed and cared for as the Union Pacific cars.

PRODUCER-GAS POWER FOR RAILROAD SHOPS.

In view of the growing prominence that the question of possible general displacement of steam engine power plants by producer-gas power plants is assuming, an examination of the matter from the standpoint of the railroad shop power station would seem to be opportune. It may be stated at the outset that the time has not yet arrived when railroad shops need give this question serious consideration. The gas plant's chief claims to attention in this regard are its greater economy as compared with even the most efficient steam plants under average conditions of fuel cost, and the relative simplicity of the plant equipment. But the first of these has far less weight in the railroad shop phase of the question than the merely theoretical or even commercial aspects of the subject might seem to warrant. For in the first place the cost of power plant operation is a small part, at most, of the total shop expense, and in the large well-designed and properly-managed plants of to-day its percentage is almost insignificant. Then, when the cheapness of the fuel which most roads can get and use for this purpose is taken into account, it will be seen that even a considerable percentage of economy in this item which might be figured for a gas plant would really be a small factor in the total expense. Not that this fact is any justification for neglecting every opportunity to increase the economy of operation of the power station; but the question involves other factors than bare economy, and the practical objections to the producer-gas power equipment from the average railroad shop standpoint far outweigh whatever of advantage it might offer in the one item of fuel.

The most enthusiastic advocate of the gas engine would hardly claim for it the reliability in operation of the steam engine, even under the most favorable conditions of running and care; and, as a matter of fact, it is at present far from being the dependable machine that the latter is. The steam engine plant can be made to do duty even when seriously crippled, and a shut-down of the shops avoided; but producer-gas engine plants go wrong in seemingly unaccountable ways at most inopportune times, and few railroad managers would care to risk any uncertainty about the continuity of their shop service merely for a few hundred dollars periodic saving on the fuel for the power station. A year's saving might be swallowed up quickly in a single shut-down. Apropos of this question of relative reliability of these two kinds of power, we have heard it stated, with what truth we cannot say, that all of the gas engine makers run their plants with steam.

Of course, special conditions may exist at shops in certain localities where it might be a wise and profitable venture to install the producer-gas equipment; we know of at least one railroad shop that at the present time is engaged in making this substitution for its steam equipment. The particulars concerning the change have not yet been made public, so that nothing in detail can be said about it at present. It is our understanding, however, that the proposition accepted by the railroad company is based on a guaranteed yearly saving, with the agreement that in the event of failure to realize this saving, former conditions will be restored without expense to the railroad company. The road in question is in the Middle West, has 823 miles of line, about 100 locomotives and 4,500 cars. The change is being made at its principal shops.

It will be understood, of course, that what has been said in the foregoing against producer-gas power plants has regard only to the particular application discussed and is not to be construed as applying to the question of the desirability of this type of power in general, particularly in those localities where coal is dear. With the attainment of properly designed producer-gas engines and of a type of producer that will gasify bituminous coal satisfactorily, and with the cost of such plants brought down to a point where they can successfully compete in initial price with steam plants, we foresee a constantly widening field for this type of power. But, to return to the railroad shop, it is a cardinal principle in railroading that economies must not be attempted where the result would be an impairment of the efficiency of the transportation machine as a whole; therefore, producer-gas power must reach a more advanced stage of development before it can be seriously considered for railroad shop power.

BOILER EXPLOSIONS.

There is but one broad general cause for all boiler explosions, and that is the simple one that the boiler was not of sufficient strength to withstand the pressure to which it was at the time subjected. This is axiomatic, and may be made to cover the multitude of contributing causes to one or more of which the explosion is usually directly attributed. In the days of not-knowing, there is always a tendency to attribute natural phenomena which we are unable to explain, to some mysterious agency, and the theories that have been propounded to account for what happened are many and strange, while few are based upon real knowledge. It matters little what may be the cause of the weakness of a boiler, whether it comes from deterioration or design, the result is that when it is not strong enough to withstand the pressure it bursts.

In the case of stationary boilers, the causes of weakness still run the whole imaginable gamut, and to the man who has been in close touch with the cheaper grades of work and unskilled attendance the wonder is not that there are so many explosions but that so many boilers hold together as long as they do. Owners and operators seem to think that a boiler is a boiler, and because it is one it can be subjected to all manner of abuse and still remain intact. But when a mud-drum head is repaired by using a flat cast plate one inch thick and three or more feet in diameter, and then subjected to a rising pressure, the wonder is that it did not let go before the 40 lbs. pressure which did burst it was reached. Of course, it could not hold, and the reaction of the steam made a fine skyrocket of the parts that remained intact. Where the water is bad and boiler cleaning difficult, the unskilled and ignorant boiler attendant is more than apt to neglect the necessary cleaning, and the thrifty owner begrudges the services of an inspector until it often happens that the boiler is really working on the strength of the scale. In one case where these conditions prevailed, the scale had formed so hard and so thick on the water-leg of a locomotive-form boiler that the metal had been nearly eaten through by the action of moisture and coal, so that when cleaning was finally done, a pin could be pushed through the sheets. How near the attendants of that boiler room were to eternity and for how long a time will never be known, but it is safe to say that the margin of escape was a narrow one. Such may be the effects of carelessness and neglect.

Maltreatment due to thoughtlessness and ignorance cannot but be regarded as a very potent cause, and this may often be due to a disregard of all principles of mechanical decency, in the setting of the boiler, whereby stresses are set up that may manifest themselves in leaks, but too frequently develop incipient cracks that hold on until some critical moment when a disastrous explosion follows. For example: A small vertical boiler was set up with the feed-pump delivery in the bottom of the water leg. The water was taken direct from a driven well and had an average temperature of about 50 deg. F. When in full action it was not an uncommon thing to see the lower part of this boiler sweating like a pitcher of ice water, while the gage indicated a pressure of 90 lbs. When it was pumped up previous to shutting down, the men complained that the water, as drawn from the blow-off cock, was too cold to wash in. Fortunately this treatment developed a big blister on the inside sheet of the water-leg, which was cut away and a heater put in the feed pipe, so that there was no disaster. But while this abuse lasted it would have been interesting and somewhat startling if the actual internal stresses set up in that boiler could have been ascertained.

These three cases are merely cited as awful examples of bad design, gross neglect and abuse; the journal of every boiler inspector of experience is filled with a multitude of just such cases.

Leaving the stationary field and turning to the locomotive, we find that quite a different condition exists, though it has not always been an ideal one. For the most part, locomotive boilers have always been in charge of men skilled in the work they have had to do, and the accusation of bad design and gross neglect cannot often be made against them, while faulty design is becoming more and more of a rarity.

The locomotive has undergone a decided revolution in its development during the past quarter of a century, and in no part has this been more strongly marked than in the boiler. When we look back at the unscientific way in which locomotive boilers were built and mounted at that time, the strange part is that explosions were not of more frequent occurrence than they were, and the only apparent explanation lies in the low pressure and thinness of the sheets, by which indefinite bendings could take place without fracture. Just consider what those conditions were. A boiler was stif-

fened and braced throughout its whole interior by tubes and staybolts and braces until its rigidity was brought up to the highest notch. It was then securely bolted or riveted to the saddle at the front and braced by two bars reaching from the smokebox down to the front buffer. It was then carefully set upon expansion plates resting on the frames at the firebox, so that it could move freely to and fro as it expanded and contracted under the varying influences of the heat to which it was subjected; but a careful examination of hundreds of locomotives would fail to reveal any evidence of any motion having taking place. Why? Principally and simply because the back end was braced down against the back end of the frame, so that, by no possibility, could there be any longitudinal movement between the firebox and the frame.

Then what happened? The pump, and later the injector, threw its stream of cold water into the front end of the shell and it settled down to the bottom, cooling that part, in comparison with the top with which the steam was in contact, and so nicely bending the boiler into an arc, with the top on the convex side, and sometimes even lifting it clear of the frames, so that the whole weight at the rear was carried by the back braces, which had a bearing against the back head of from 50 to 80 sq. in. To what useless stresses was a boiler subjected that found itself in that condition? Well, we did find that the sheets were apt to bulge and yield, and after many years of this sort of work we slowly arrived at the conclusion that these back braces had best be omitted. In the meantime, what with light frames and bad cross-bracing, and the impossibility of proper expansion, the boiler was called upon for all manner of services, from transmitting the pulling effort of the cylinders to the tender and taking up buffing shocks, to carrying the pressure and generating the steam.

And how about the boiler itself? It seems strange that the simple lap seam should have persisted for so many years, when the story of its inefficiency and misconduct was told at every inspection. With a lap seam, the shell of the boiler could not be made truly cylindrical, nor could the internal pressure bring it into that condition without a distortion of the metal at or near the lap. This distortion usually occurred at the edge of the lap on the inside, where it was concealed from view by the tubes and scale and was of such magnitude that the metal was strained beyond the limits of its elasticity and so at first took on a permanent set, then cracked and gave the water entrance to the interior. Then corrosion started at once and grew until it manifested itself as grooving. Since bending will always occur at the smallest part, this section that was made smallest by cracking and corrosion was obliged to sustain all the strains due to the adjustment of the shell to the internal pressure, until at last the plate became too weak to sustain the load and it gave way. Then we had another explosion, due to grooving, and we wondered what could have caused that grooving, and laid the fault at the door of galvanic action, or acid in the water, or defective plates, or carelessness in handling the plates during construction, and did not for years look to what we were doing in the use of the lap seam.

But this is of the past; the lap seam has gone, never to return for locomotive work, and if state legislatures really want to interfere in such things they can well enact a statute making it a criminal offense to use it on any kind of stationary work.

With the disappearance of the lap seam, one of the most prolific causes of locomotive boiler explosions was done away with, and the seat of these disasters was transferred, as it were, from the shell to the firebox.

When the firebox was set down between the frames, and the length was limited to the allowable clearances between the eccentric straps at the front and the rear axle at the back on the American or 4-4-0 locomotive, there was comparatively little difference in the expansion of the inner and outer side sheets, so that while staybolt failures were not unknown they did not assume the proportions that they did later, when the fireboxes had been lengthened and widened as in modern designs. Although the to-and-fro movement of the sheets bends the bolts and breakages are frequent, sometimes almost appallingly so, the points on the firebox most likely to suffer from such breakage are so accessible to inspection that disaster has been very successfully averted. It is a rare occurrence that a locomotive boiler explodes because of an accumulation of broken staybolts, though this does sometimes happen. If, then, we have removed boiler explosions from the shell because of the use of the sextuple riveted welt seam, and can protect the firebox from failure because of broken staybolts, it would seem that there is little else to cause trouble. Yet we know that locomotive boilers continue to explode, at the rate of about three a month, taking the country as a whole. This is certainly a large enough figure, but it constitutes a small percentage of all boiler explosions that occur. For example: From Sept. 1 to Dec. 31, 1906, 152 boiler explosions were reported, of which 14, or less than 10 per cent. of the whole, were on locomotives.

It may be assumed that we have now learned fairly well how to design a locomotive boiler and place it upon the frames in such a way that it will not be subjected to abnormal strains, so that, when such a boiler does explode we may usually look for the immediate cause elsewhere than in the design. Broadly stated, there may be two causes for undue deterioration of the modern boiler: one in neglect and the other in abuse at the hands of the driver. Neglect may take the form of failure to wash out at intervals of sufficient frequency to prevent the accumulation of mud and scale in the interior, or it may occur through the omission of inspections by which the condition of the staybolts can be watched. Press of work upon the road and the consequent demand for engines is responsible for much of the neglect of washing; or sometimes the delay is due to the fact that the engine is marked up for the shop, and it is not considered worth while to wash out for only a few days' run. But when a boiler is opened and it is found that it contains three or more wheelbarrowfuls of sediment, the evidence is pretty good that someone has been taking chances. The chemical properties of the scale itself may be so inert that no direct attack is made upon the metal, but its non-conducting qualities shield the plates from the absorption of heat by the water and overheating and the resultant injury takes place.

In regard to overheating, it is not probable that a general elevation of the temperature would be injurious to the sheets. That it should be, hardly stands to reason, for the sheets are heated in all flanging processes without injury, provided they are properly cared for. It is local heating that does the mischief, by setting up internal stresses that hold the metal in tension until something yields. It is not often that overheating upon a boiler in service is anything more than local; but when it is, the statement is corroborated. An instance of this is to be found in the case of a night switching engine that was standing for some time, and on which the crew went to sleep. They were awakened by the burning of the cab, and found not only that, but the wooden lagging in flames, with the firebox and back head red hot. Steam had risen while they were asleep and the boiler had emptied itself through the safety valve, and then the fire came up and caused the overheating. Of course, it was supposed that the boiler was ruined, and it was taken to the roundhouse. But a most thorough inspection failed to reveal any defect other than a few leaky tubes. So these were rolled out, the lagging and cab replaced and the engine sent back to work. That the boiler was uninjured is evidenced by the fact that it remained in service for twelve years thereafter without requiring new sheets! So it is safe to say that local overheating is the danger, and an accumulation of scale is a good way to cause it.

The fact that the men in charge and those employed in the locomotive power department are skilled has led to the belief that the locomotive boilers in their care are well looked after. This presumption is strengthened by the small number of locomotive boiler explosions that occur. It has always been held superfluous for the state to interfere in the matter, as it has been considered that the railroad officials were doing and would do all that any statute could possibly enact. Two years ago, however, the New York legislature passed a law requiring an inspection of every locomotive boiler in the state at least once every three months, and a report upon its condition filed with the railroad commission. This was amended in March of this year by adding some further requirements. This statute has been generally regarded as useless, because unnecessary, but if the statement from the twenty-fourth annual report of the commission is true, the condition of affairs before this periodic inspection was enforced was deplorable. According to this report:

> "Prior to the passage of the boiler inspection law many roads made no inspections at all, while others employed 'handy men' or other incompetent inspectors, which meant that boilers were often operated under dangerous conditions. Several roads operating in this state have no mechanical officers, consequently the boilers in the past received little or no care. These roads now realize the danger of operating old and ofttimes cast-off locomotives from other roads, and are inspecting the boilers regularly. The larger roads made inspections for or less thorough and with varying degrees of regularity, dependent on the demand for power. In busy seasons inspections and repairs were often of a most superficial character, and the safety of the boiler was a matter of doubt."

This is certainly a pretty stiff arraignment and one that should be followed by some modifications. To those who are in touch with this matter it is a known fact that the reports of boiler conditions

have been most regularly and efficiently rendered, and it would not be difficult to name roads within the limits of the state where there is a complete record of the condition of every boiler, and of every staybolt, for years, taken at monthly or bi-monthly intervals. Had there been any widespread neglect of these boilers, explosions would have rivaled in frequency the popping of firecrackers on our national birthday. The comparative immunity from locomotive boiler explosions has been due to good management, not to good luck.

It is an unfortunate fact, however, that there are cases of neglect and sometimes of faulty repairs. When soft patches are used on the inside of a firebox, it is simply an invitation to disaster. To be sure, disaster does not always accept the invitation, but the encouragement thus offered to a bad practice is more dangerous than a prompt failure of every soft patch would be, by stimulating the expectations that the boiler will hold. Once in a while a bad matter is made worse by the use of a copper patch in a steel firebox because this metal is more easily shaped than a steel sheet would be. Then, when such sheets do let go, instead of laying the calamity on poor Providence and calling it an accident, it should be recognized as a crime and the man responsible promptly sent to the penitentiary to think over the advisability of using soft patches or other dangerous means for repairing steam boilers.

Collapsed tubes are probably the most common form of boiler failure, and while they do not properly come under the category of explosions as the term is generally understood, they are dangerous and should be avoided as far as care and inspection will permit. On European roads, where brass tubes are used, much trouble is experienced from the scoring of the inside surface by the small particles of coke or coal. In this country the same difficulty is experienced, but to a much less extent.

The railroad companies may, therefore, be held accountable for preventable deterioration that occurs as the result of neglect of inefficient repairs. But it is regrettable that the carelessness of the engineman is responsible for so large a proportion of terrific explosions. Usually this carelessness manifests itself in low water, an overheated and collapsed crownsheet, and then a wrecked engine and men killed. As has been stated, low water in itself, with the resultant uniform heating of the crownsheet, need not necessarily cause an explosion or injure the plate; but when this heating is carried to so high a temperature that the metal is weakened and cannot sustain the steam pressure above it, it will yield and tear away from the stays, and the explosion is at hand. When this happens, the sheet always tells its own story of the treatment that it has received, and there can be no question whether it was overheated or not, as this is clearly proven by its color.

Given a rupture large enough to cause an explosion, no man can foretell the course of the tear or what will happen. Naturally, the rent follows the line of least resistance, but what this is likely to be no one can say. After the explosion, an examination of the metal is apt to show that it has been overstrained, so that physical tests of the metal of an exploded boiler cannot be relied upon to indicate its true condition previously.

The results that are witnessed when a boiler explodes can well be compared to what would happen were a powder magazine to be ignited. The heat of the contained water is sufficient to cause a percentage of its own volume to flash into steam, and this, with the expansive properties of that already existing, is sufficient to follow up any weakness and act as a constantly decreasing accelerating impulse to project the parts away from the point of rupture. Usually, in fact it might almost be said invariably, the boiler tells a very graphic story of what has happened to it and why it happened. The point at which the rupture started is usually so clearly indicated as to leave it in no manner of doubt, and from this the course of the rent can be followed and the general path of the boiler through the air can be determined. With the commencement of the fracture located within an inch or two, an examination of the metal at that point will usually fix the exact cause, whether it be an overheated sheet, a broken staybolt, a corroded or cracked sheet or a case of bad repairs.

Often when the cause is an overheated sheet, it is inferred that the engineer was putting water in the boiler at the time; but this is not necessarily so. If the specific heat of steel and water be compared it will be seen that the heat of the latter is so low that the amount of water that could be flashed into steam at boiler pressure by coming in contact with the steel would be so small as to be insignificant; hence it can be disregarded. In fact, attempts to explode boilers by such treatment have not been successful. To be sure, this does not tend to improve the quality of the sheet, but it is doubtful if it ever caused an explosion. Usually a hot sheet yields by tearing away from the stays or bagging until it bursts, and not as the result of a sudden increase of pressure.

Among the favorite theories of the past for the explanation of boiler explosions was that of the spheroidal formation of water and steam. According to this, the steam accumulates beneath the water as it does beneath the drop on a hot stove, and by holding the liquid in suspension, increases in pressure until it can be held no longer. Then it was supposed to burst up through the superincumbent mass with terrific force, and the explosion would ensue. It may suffice to say that there is no evidence that this has ever occurred. Water that is perfectly calm and quiet, uniformly heated, may, by the exercise of care, be raised to a temperature above that corresponding to the pressure to which it is subjected, without ebullition, but the slightest jar or inequality in the application of heat will stop this increase and ebullition will take place instantly. That such a condition should ever obtain in a locomotive boiler at rest is unbelievable; when it is in motion, it is clearly out of the question. And even when this is accomplished, the increase in temperature is too small to be considered as a factor capable of causing an explosion.

The water hammer has also been held responsible for boiler explosions, and this may have been the case with some ruptured steam pipes in stationary practice, but where the water hammer can occur or what can produce it on a locomotive is difficult to say; so that it may be passed by as a mere guess that can hardly be qualified as even ingenious. Sifted down, then, it truly does appear that boiler explosions are due to weakness of the boiler, and it appears that this weakness may be caused by inherent defects in design or in the metal; by neglect on the part of those charged with the care, cleaning and inspection of the boiler, and by carelessness on the part of the driver. Whatever may be the cause, the exploded wreck will usually tell a straight story of what has happened, that will admit of no dispute to him who has the eyes and training to read the book as it is written.

CONTRIBUTIONS

Holding Force of Railroad Spikes.

Maurer, N. J., May 25, 1907.

To the Editor of the Railroad Gazette:

Referring to the article in your issue of April 26th entitled "Holding Force of Railroad Spikes in Wooden Ties." You will find that the results obtained by the Forestry Department are directly contrary to those obtained by the Engineering Experiment Station at Urbana, Ill., the latter having found that creosoting increases rather than diminishes the amount of pull required to start a spike of any kind.

J. C. WILLIAMS,
Supt. Wood Preserving Plant of The Barber Asphalt Paving Co.

A Solution of the Oil-Burning Locomotive Problem.

BY HARRINGTON EMERSON.

A liquid fuel should, by its very nature, be much more efficiently burned in the firebox of a locomotive than coal, both from the standpoint of economy of fuel and also in the control and distribution of the heat liberated from the fuel over the different surfaces of the firebox. Actual practice on roads using both kinds of fuel shows that it costs nearly twice as much to maintain oil-burning fireboxes as it does those using coal. The rapid deterioration when oil is used is due to four causes: unequal distribution of the heat; wide variation in firebox temperature, carelessness in handling, and overtaxing the firebox.

The first cause is due to faulty construction of the usual fire brick arch, in that it does not distribute the flame over the firebox but rather concentrates it on the crown-sheet and parts of the side sheets. This fault is also aggravated by the blast effect of the burner. This unequal distribution of the heat causes certain parts of the firebox surface to do much heavier duty than these which are less exposed to this blast effect. Very frequently the heat is so intense at the points of concentration as to drive the water from the sheets, and the staybolts, rivets, etc., being left unprotected by the water, are burned away. Excessive strains are also set up in the different parts of the firebox by the unequal temperature, causing seams to open up and staybolts to break. This is one cause of excessive boiler repairs.

The second cause—the wide variation in temperature at different times—is due to the fact that, in common practice, no provision is made for maintaining a comparatively high temperature in the firebox at all times. The location of the draft openings and the comparatively small radiating surface of the arch make it possible at times to draw large volumes of cold air into the firebox

when the engine slips, or in drifting down hill, or when, for any reason, the fire is cut down. In a coal-burning locomotive this indraft of cold air is not possible as, with the grates well covered with burning fuel, no air can enter the firebox without first having passed through the bed of fuel.

The third condition may and does exist in handling both kinds, but the coal fireman, in order to keep up steam, must at all times keep the grates well covered, thus protecting the firebox against an inrush of cold air, while the oil fireman may, by careless handling of the firing valve and failure to follow the engineman in his use of the reverse lever and throttle, vary the temperature in the firebox 2,000 deg. in a moment of time, thus causing terrific expansion and contraction of sheets, staybolts and rivets.

The fourth cause, that of overtaxing the capacity of the firebox, is due to the higher heat or fuel value of oil as compared with coal, the capacity of a boiler or firebox frequently being doubled by substituting oil for coal. The hauling capacity of an oil-burning locomotive is often only limited by its weight on drivers and the ability of the drivers to hold to the rail. This has led to the overloading of oil-burning locomotives and is one of the most common causes of firebox failure and the high cost of maintenance.

The chief differences between oil and coal burning are:

(1) Per pound, oil contains 50 per cent. more heat units than coal.

(2) Per heat unit, oil requires less air than coal.

(3) In oil burning, the air does not have to pass through a bed of ashes, cinders and coal, therefore the same vacuum in the smokebox will draw 50 per cent. more air through the flues.

(4) Oil is mechanically fired, therefore there are no limitations as to length of firebox. The economical steaming limit of a locomotive is that of the economical vacuum in the smokebox. In burning oil, for the same vacuum more pounds of fuel are burned and for each pound more heat is liberated. It follows that the design of an oil burner as to burner, firebox and tubes should be radically different from that of a coal burner.

The amount of heat passing through the sheets of the firebox and through the tube walls depends on the difference in temperature on the two sides of the sheets or tube walls. In a coal burner, by pyrometric measurement the temperature 3 in. from the side sheet was found to be 1,300 deg. F., but in an oil burner it was found to be 2,700 deg. F. It is evident therefore that the strains on the firebox are greater for oil, and that water spaces sufficient for coal will be too narrow when oil is used. The remedy is to enlarge the firebox greatly, thus reducing the heat transmitted per square inch. If the firebox is not enlarged, then the water spaces should be of a special form and construction adapted to lessen firebox strains. If it is expedient to enlarge the firebox in order to lessen differences of temperature at the two sides of the firebox sheets, it is also expedient gradually to diminish the area of the tubes from firebox tube sheet to smokebox tube sheet.

As far as the tubes are concerned, it is a mistake to suppose that increased heating surface is of direct proportional advantage when differences of temperature are great. The speed with which heat is transferred is so enormous that the area of heating surface is of insignificant importance compared to temperature differences. The velocity of the gases passing through the flues when a locomotive is developing maximum power averages 2,000 ft. a second, therefore they pass from end to end of even the longest tubes in the one-hundredth part of a second. At the firebox end of the tube the velocity is much higher than this average.

The temperature drop in an oil burner is nearly 2,000 deg. F. from firebox to smokebox, and one-half of this, or 1,000 deg., occurs in the first 5 ft. of flue. Therefore, in the four-hundredth part of a second there is a temperature drop of 1,000 deg. That is "going some!"

It is much more important to have thin tubes and to maintain a high velocity of the gases than to retain heating surface. If all the gases from firebox to front end passed through a single tube, theoretically it would be quite as efficient as many tubes; actually, it would not, owing (1) to the non-transparency of the tube iron to heat, (2) to the increasing frictional resistance of the tube walls to high gas speed, (3) to the defects in water circulation on the outside of the tube.

Because in an oil burner there are no cinders to clog up the tubes, because the tubes can be kept cleaner, because a larger firebox surface is needed to absorb the larger volume of heat evolved, the oil-burning locomotive can be equipped with tubes both shorter and of smaller diameter than with coal, thus making the tube heating surface much more effective. The chief modification of the oil-burning locomotive should be:

(1) Larger water spaces around the firebox.

(2) Different construction of firebox, preferably with submerged seams and non-rigid suspension.

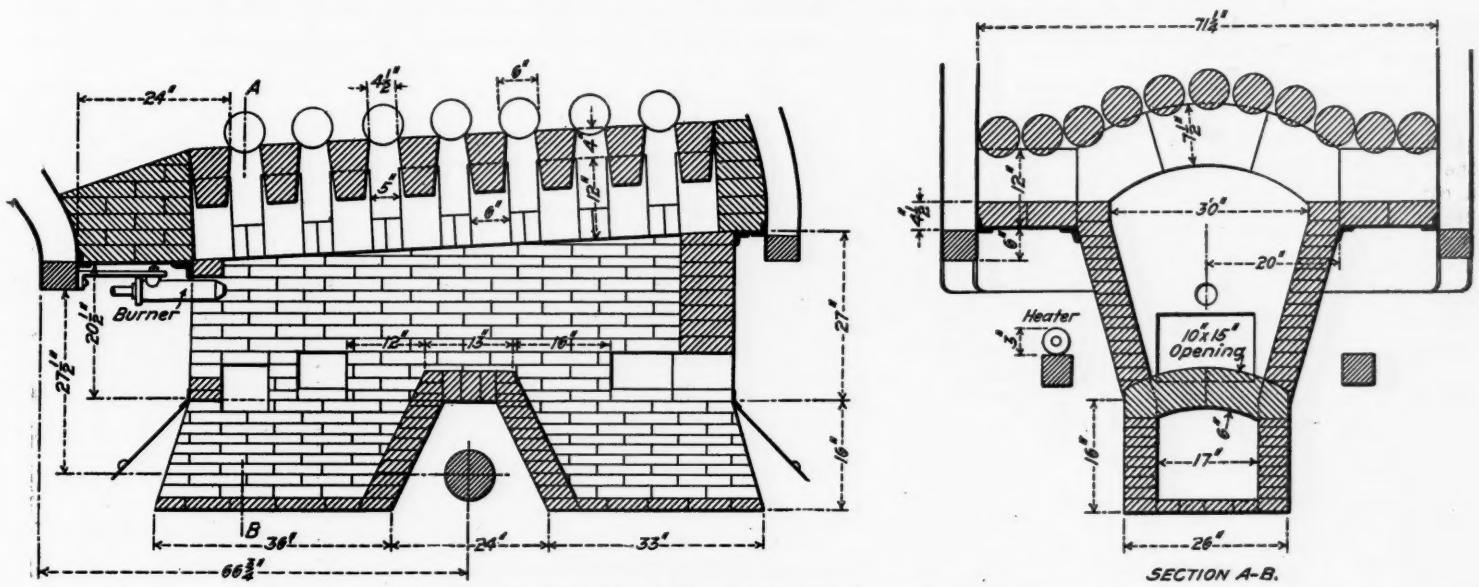
(3) A much larger firebox or combustion chamber.

(4) Shorter and thinner tubes but more of them, preferably diminishing in area from firebox to smokebox.

These changes rest on the assumption that oil can be more perfectly burned than coal; that is, it can be burned with less production of carbon and smoke, much less surplus of air to insure perfect combustion, and therefore much less expenditure of power to produce the required draft. Also, owing to the fearful strains in the firebox due to the high heats, the more the heat of combustion can be emitted and absorbed as radiating heat and the less by actual contact of the sheets with the burning gas, the better it will be.

A theoretically and practically satisfactory solution of this part of the problem has been secured by the use of the Neely furnace as applied to oil-burning locomotive fireboxes. It was designed by Mr. Thomas W. Neely, in charge of oil-burning economies in connection with the Santa Fe betterment work described in the *Railroad Gazette* Nov. 30 and Dec. 7, 1906. It is illustrated in the accompanying drawings. Instead of injecting the burning gases directly into the firebox where, during the act of combustion, there are not only tremendous variations in temperature but also an exceedingly active chemical corroding action, the burner is separated from the firebox by a perforated horizontal or arched wall of fire brick. The burner is placed in the front end of what the inventor calls the "developing chamber." The construction of the burner is such as to use a minimum amount of steam for atomizing the oil, and both the position and action of the burner induce past it a flow of air which is thoroughly mixed with the atomized oil and steam.

As is well known, the presence of a small quantity of steam materially aids perfect combustion, it being supposed by some that



The Neely Furnace Applied to Pacific Type Locomotive.

The burner, it will be noted, is at the front of the developing chamber. Air is drawn in around the burner and also through the doors in the pan, which are controlled from the cab. The balls are of specially prepared fire brick. Much of the initial combustion takes place below the arch and balls. Even if the whole arch collapses, as has occurred, there is no engine failure, as in this condition it is still as good as standard construction. The burner being at the front, the gases are shot backward and thus heat the door sheet. By varying the spaces between the arches and using different sizes of balls the flames can be distributed as desired.

the carbon will not readily combine with oxygen except in the presence of hydrogen; there may also be some obscure catalytic action, analogous to that of platinum sponge, which glows in the presence of escaping hydrogen. Be this as it may, the atomized oil, steam and air in Mr. Neely's furnace are initially burned in a separate chamber wholly surrounded by fire brick and immediately under the firebox. This chamber becomes intensely hot, and its design and heat operate (1) to heat the incoming air, (2) to mix thoroughly and heat all the gases before they pass into the firebox, and (3) to radiate a non-chemical heat to the firebox walls.

The flames being subdivided and baffled by the porous arch are forced to all parts of the firebox equally, thus doing away with any blast effect on any particular part of the box. Any unburned gases, in passing through the porous arch, which is kept at a white heat, are brought up to the combustion temperature maintained at such temperature until combustion is completed, thus preventing the deposit of carbon. The porous arch also causes the oil vapors and the air to be forced into intimate association, which results in quicker and more perfect combustion and makes it unnecessary to use any considerable excess of air in burning the oil as is the case with the ordinary arch. Whenever the fire is cut down, all air admitted to the firebox must pass through the highly heated arch, and being forced into intimate contact with the large heat-radiating surfaces of the arch and passing through comparatively small openings, the air is brought up to the temperature of the arch before being admitted to the firebox. Firebox temperatures vary but slowly.

It is a matter of common daily practice on the heaviest Santa Fe type locomotives to maintain the full steam pressure (225 lbs.) against two No. 11 injectors without a trace of color of smoke at the stack. There is but little difference in the evaporative efficiency of the boiler under different rates of duty owing to the uniformly good combustion. To show the results thus far secured with this equipment it will only be necessary to cite a few examples as found on the Gulf Lines and Coast Lines of the Santa Fe System, where the equipment is being used. On the Gulf Lines, engine No. 664, a consolidation with 21 in. x 28 in. cylinders and 180 lbs. steam pressure, was taken from the hospital track, where it was awaiting a new firebox, the Neely equipment was installed in the old firebox and the engine put into regular freight service. The records show that for the eight months following, the running repairs on this engine were a little more than half what they were during the eight months previous and the mileage was almost doubled.

Eighteen Santa Fe type locomotives now in service with this equipment on the Coast Lines are costing less than 1¼ cents per mile for brick work, boiler work, burner, piping, etc.—that is, all repairs not chargeable to machinery. These engines are averaging 3,800 miles and upward per month on one of the hardest divisions on the system, owing to heavy grades and poor water. The tonnage on this division was raised 50 tons per engine March 1, 1907. Engine No. 948, now in the fourteenth month out of the shop, is costing less than $10 per month for boiler work, and its shopping within the next three months will be rendered necessary only by the condition of its machinery. The boiler work on all these engines is averaging less than $12 a month. Almost no work at all is done on seams, radial stays and staybolts, and there is but little appreciable deterioration of the firebox. It is impossible at this time to say just what the life of the fireboxes on these engines will be. It is safe to say, however, that it will be at least double that of those fitted with the ordinary oil-burning equipment.

The results on the Coast Lines with the 18 engines above mentioned were attained at a time of heaviest traffic and when, by the promotion of firemen, many engines were manned by men who were unskilled in the duties required of them on their respective sides of the engine cab.

The principal features of the burner used are the high efficiency in atomizing and the suction effect by which a part of the heated gases from the furnace are drawn into the head of the burner and discharged with the oil and steam. The oil is thus almost completely atomized and vaporized when it leaves the burner. The amount of steam required for atomizing is about one-third of that required by burners commonly employed in locomotive practice. The suction effect mentioned sets up a counter-flow of the gases in the firebox or furnace along the sides and toward the burner, thus causing an even temperature in all parts of the developing chamber.

As an example of what is being accomplished in stationary practice, it may be stated that in one of the power-houses of the system a 125-h.p. boiler has been for hours at a time developing 206 boiler horse-power at a rate of evaporation of over 12 lbs. of water per pound of oil, the steam pressure being 120 lbs. The water evaporated by this boiler showed repeatedly above 6,000 lbs. per hour. A burner on one of the boilers in this power house was recently removed after having been in continuous service for over two years without any repairs whatever.

For locomotives, on the basis of like total amounts of water evaporated, the cost of maintaining the Neely oil burners is less than that of the coal burners, although the oil furnace is used in a boiler primarily designed for coal, and its adaptation to oil therefore more or less of a makeshift. After two years of experimental work on the Texas Lines, Mr. Neely was authorized to equip the 18 new Santa Fe type (2-10-2) engines, weighing 235,000 lbs. on drivers, already referred to. The boiler and furnace repair costs of these engines have been most carefully kept, a special force being detailed for that purpose. The figures are as follows:

	Cost per mile, cents.	Per cent. of whole.
Furnace	0.69	55.6
Firebox and flues	0.23	18.7
Burner	0.13	10.5
Pan and damper	0.10	8.0
Front end	0.08	6.7
Boiler	0.01	0.4
Total	1.24	99.9

These 18 engines have not been in service long enough to permit comparisons with engines differently equipped; but on the Texas Lines it has been possible to compare the cost of maintaining the same engine first with standard equipment and then with the Neely equipment.

Cost for All Repairs per Engine-Mile.

Engine No.	664, standard equipment, August, 1905	$0.113
" "	664, Neely equipment, August, 1906	0.036
" "	666, standard equipment, 4 months, average	0.102
" "	666, Neely equipment, 4 months average	0.042
" "	111, standard equipment, 8 months, 1905	0.081
" "	111, Neely equipment, 8 months, 1906	0.024

This last comparison is vitiated, however, by the fact that a new firebox was put in at the time of installing the Neely equipment. In the other cases the fireboxes with the Neely equipment were the older.

As shedding additional light on the whole question of oil versus coal, as well as usual oil-burning methods versus improved oil-burning methods, figures are available covering:

(1) The same type of engine in similar service burning coal and burning oil.

(2) The same type of engine burning oil in the usual manner and burning oil in the improved manner.

(3) The same engine burning oil in the usual manner and in the improved manner.

	Burners—Coal	Burners—Oil
No. of engines	41	40
Time	12 mos.—1906.	12 mos.—1906.
Class	900	900
Service	Freight.	Freight.
Weight on drivers	234,580 lbs.	234,580 lbs.
Division	New Mexico.	Arizona.
Average mileage per engine	26,391	24,233
" miles per month	2,199	2,019
" gross tons per mile	874.5	968.4
Repair costs per mile, excluding wrecks:		
Roundhouse: Labor	$0.0568	$0.063
Material	0.0182	0.027
Total	$0.075	$0.09
Back shop: Labor	$0.057	$0.083
Material	0.039	0.043
Total	$0.096	$0.126
Grand total, repairs per mile	$0.171	$0,216
Wages per mile:		
Enginemen and firemen	$0.114	$0.089
Hostlers and attendants	0.044	0.017
Miscellaneous supplies	0.005	0.003
Grand total cost per mile*	$0.334	$0.325
Grand total, per 1,000 gross ton-miles	$0.382	$0.331
Total lbs. of fuel per engine-mile†	263.3	226.6
Dollars of repair cost per ton of fuel	$1.33	$1.96
Gross ton-miles per ton of fuel	6.72	8.55

*Not including fuel or wreck repairs.
†60 tons of oil equal 100 tons coal.

This tabulation indicates that repairs are heavier for oil-burning locomotives both as to material and labor, but that the oil-burners, when out of the shop, are easier to operate in all respects, as they burn less fuel, take heavier loads and cost less for supplies, for hostlers and for engine crews. As machinery wear is less severe on the Arizona division, the grades not being as heavy nor the curves as sharp, the extra expenses occur in the oil-burning part of the locomotive from dampers to stack. Therefore, as to this class of repairs a comparison has been made between similar engines equipped with Neely furnaces and equipped with standard furnaces.

	Furnaces—Neely.		Furnaces—Standard.	
No. of engines	12		5	
Time	April, 1907.		April, 1907.	
Class	1,600		1,600	
Service	Freight.		Freight.	
Weight on drivers	234,580 lbs.		234,580 lbs.	
Division	Arizona.		Arizona.	
Fuel	Oil.		Oil.	
Total miles	46,577		15,241	
Average miles in month	3,881.4		3,233.5	
Average miles of 900 class for year 1906	.....		2,471.5	
Repair costs per mile, in cents:	Cents.		Cents.	
Furnace repairs	0.90	60.1 pr ct.	1.1	53.9 pr ct.
Burner and piping	.18	12.1 "	.06	3.0 "
Firebox and flues	.29	19.1 "	.83	40.8 "
Boiler	.03	1.8 "	...	....
Pan and damper	.08	5.7 "	.02	1.0 "
Front end	.02	1.2 "	.03	1.3 "
Total	1.50	100.0 pr ct.	2.04	100.0 pr ct.

The high costs for piping and damper work are temporary and due to the initial necessity of altering the standard arrange-

ment to conform to change of equipment. The above record for a single month is sustained by the records of longer periods.

Total repairs, as above, for standard engines of 1,600 class, from December, 1905, tol December, 1906, per mile.....	$0.025
Total repairs Neely equipment, December, 1906, to May, 1907, per mile	0.015

Sixty per cent. of all engine failures in this class in this heavy service are due to firebox and flue troubles. The greater mileage of the Neely-equipped engines is due to fewer failures in firebox and flues.

The Neely furnace, because of its more perfect combustion, is supposed to be more economical in oil. Owing to the extraordinary difficulty of securing reliable oil records over a long period of time, no attempt has yet been made to demonstrate this.

It appears that the great value of the Neely equipment lies in the fact that the firebox and flues stand up better, do not leak, therefore do not cause engine failures or require shop repairs and thus cause delays. As a consequence the same engines made about 20 per cent. more mileage a month when equipped with the Neely furnace. Engine 948 when running with standard equipment averaged 2,030 miles per month. Since equipped with the Neely furnace, although 14 months out of shop and ready for heavy repairs, it has averaged for five months 3,389 miles per month, or 67 per cent. more.

If the Neely furnace could be supplemented by a longer firebox, wider water spaces and shorter tubes, such a properly designed and operated oil-burning locomotive would undoubtedly prove far more economical to maintain and more convenient to operate than any coal burner.

Norfolk & Western Improvements.

BY GEORGE L. FOWLER.
Associate Editor of the *Railroad Gazette.*

IV.

YARD OPERATION.

It is on that division of the Norfolk & Western extending for the 105 miles between Bluefield and Williamson, as previously stated that about 62 per cent. of the traffic moving over the road originates. This division is known as the Pocahontas division and traverses the heart of the semi-bituminous coal region of West Virginia. It is here that the celebrated Pocahontas coal is mined, a coal that ranks with the best of the Welch for calorific values and steam producing qualities. To the west of the Pocahontas field lie the veins of the Thacker coal, a field ranking high as a steam maker, but containing a little more volatile matter than the Pocahontas and lying on a higher level geologically, so that the approach to anthracite is a little more remote, as the natural coking process has not been carried on for quite so long a time. With a location through these two fields, whose product ranks so high and is so favorably known the tonnage is naturally high. Consequently the coal and coke tonnage for the last fiscal year, ending June 30, 1906, was 13,474,246 tons, which includes 1,012,418 tons of coke and gas and steam coal from the Clinch Valley field which lies to the southwest of Bluefield on the Norton line. These figures are the result of the rapid growth of the output since the opening of the original mine at Pocahontas in 1883. In the first year after the opening of the mines there was but one operation with a total output of 80,633 gross tons. This has increased to the present proportions at the rate shown graphically on page 354 in the issue of March 15.

The cars in which this traffic is handled consist of hopper bottom, gondola, rack coke, box and stock cars. The hopper bottom cars are of widely varying capacities. These are 20, 25, 30, 40 and 50 tons. The cars of 20 and 25 tons capacity are being rapidly retired from service and when they are found to require more than $50 in repairs they are consigned to scrap. The 40 and 50-ton cars are used almost exclusively in the tidewater and eastern industrial trade, while the gondolas, that are of 30, 40 and 50 ton capacities are used mostly for the western trade where the receivers of coal and coke have been slow in acquiring unloading stations adapted to the economical use of the hopper bottom or self-clearing cars, such as are employed in the east with large savings in cost of handling materials. The rack coke cars have a carrying capacity far above that of their holding on account of the lightness of the material of the load. The rated capacities are 20 and 50 tons, but the actual load carried ranges from 20 to 30 tons. The company also have a number of large steel hopper rack cars (some of which have a wooden rack) with a side dump.

From the geological map of the territory served by the Norfolk & Western it will be seen that the Pocahontas field lies at the eastern extremity of the Pocahontas division, while the Thacker abuts against it and lies at the western end of the same. It is evident then that the Thacker coal, in order to reach the eastern markets, must pass through the Pocahontas territory, so that, as a matter of fact, the greater portion of it is mined for a western delivery, and again, while the larger percentage of the Pocahontas coal goes east, there is also a large tonnage shipped to the west.

With these facts in mind regarding the importance and value of the Pocahontas coal in the markets, especially on the coast, it is readily understandable why the Norfolk & Western was called upon to build a very large receiving and distributing yard at Bluefield.

There is almost no coal mined east of this point. The famous Pocahontas fault occurs a few miles west of Bluefield and this defines the limit of coal production as clearly as any artificial demarkation could do. The yard then, is outside the coal producing belt, and all freight of this character, originating on the line, comes into it from the same direction, namely, the west, passes through it and on out at the east.

During the last fiscal year, the tidewater shipments of coal and coke amounted to more than 3,450,000 tons, to which must be added about 5,000,000 tons more than went east, making the total coal and coke tonnage that passed through the Bluefield yard in the neighborhood of 9,000,000 tons.

It is, therefore, necessary to have ample facilities for the handling of this traffic, hence the Bluefield yard.

BLUEFIELD YARD.

In order to understand the method of handling the traffic a word must be said in regard to the system of selling and shipping Pocahontas coal. Of course, it is all carried in carload lots and the capacity of these cars ranges from 25 tons, in the case of the old cars that are now becoming obsolete, to the latest type of steel construction, which has a capacity of 50 tons. The coal is mined and placed upon the cars and shipped to Bluefield direct from the tipple of the operation producing it. As these tipples are located all along the line and its numerous branches to the number of 160 or more, it is, of course, impracticable to maintain an agent either for the producer or the railroad at each of them. The system is, therefore, so arranged that neither is necessary. The coal is sold through agents each of whom handle the output of several operations. A few years ago all of the coal of the Pocahontas field was sold by a single agency. The coal put in the cars at the tipple is, therefore, sent to its selling agent at Bluefield. No waybills are made out and no record kept, the car is simply loaded, a tag attached and sent away. This tag, which is reproduced, gives the operation at which the load originates, the initials and number of the car and the name of the shipping agent at Bluefield, to whom it is consigned. The cars are gathered from the operation sidings by shifting engines and crews. They also pick up, at the same time, all other cars that are empty or filled with general merchandise. These last cars are waybilled and consigned, in the regular way, from the station where an agent is maintained. For operations located on the main line, the cars are collected by the regular trains and are mixed in with box and other merchandise cars. A train may, therefore, come into the Bluefield yard with every car tagged to a shipping agent, or it may have one or more accompanied by waybills.

The conductor of these trains makes out a switch list on the form shown in which he lists only such cars as have waybills and regular consignments and ignores those loaded with coal. The result is that it frequently happens that not a single car is listed on the card handed in by the conductor, or at most one or two stray merchandise cars that happen to have been picked up. The consequence is that there are no records of the numbers, loads or destination of the coal cars when they reach Bluefield.

The train is run in on the eastbound receiving track and stopped just short of the scale house. The first move is to send a boy down the side of the train who collects all of the tags and marks on each one the tare weight of the car from which it is taken, keeping them in the order in which they are collected. He then takes them to the office of the weighmaster at the scale house. The data contained thereon is then transferred to a book. This comprises the name of the shipping agent, the initials and number of the car, its tare weight and the operation at which the load originated. These last are all recorded by number, one being given to each in the field. These numbers are printed in red on the face of the tag referred to above, so that a glance suffices to tell the source of the load.

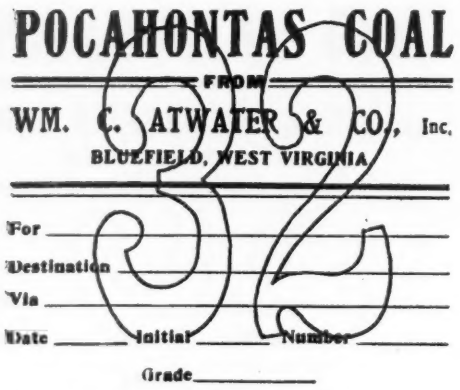
As a general thing the agents are notified in advance from the operation as to the initials, number and capacity of each car that has been loaded and consigned to them during the day. With this information at hand, the agent is prepared to make up a shipping list, which is sent to the weighmaster, and from which the waybills for each car is made out. This information is usually sent in the form shown, before the train containing the cars reaches Bluefield.

This enables the weighmaster's clerk to fill in the destination and consignee of each car. Should this shipping list or order not have been received at the time of the arrival of the train, the agent is informed by telephone of the arrival of the cars and asked for the shipping directions, which are at once forthcoming. This makes it possible to complete the switch list card and hand it to the con-

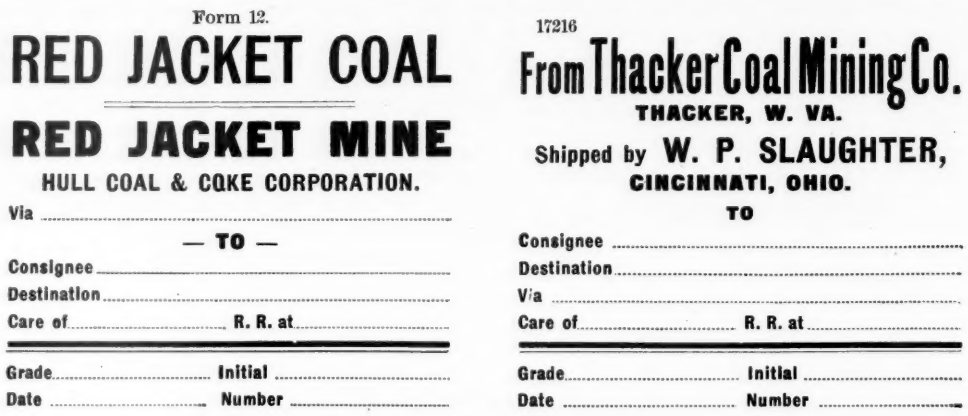
ductor of the switching crew. This work is all done while the car inspectors are going over the train, which requires from 15 to 20 minutes.

The yard is of the gravity type and the cars are let down over the scales which automatically registers the gross weights. The cars are then run into the proper tracks of the advance classification yard as detailed in the description of the Bluefield yard, in accordance with the information contained on the switch list. The gross weight having been obtained from the scales, the figures are read off in the order of the car locations in the train. This, of course, corresponds with that of the tags that have already been handed in and entered in the register book. These gross weights so as to save time and writing on which the name of consignor and consignee, class of lading and destination are printed in, leaving nothing to be inserted by hand but the car number, date and weights, as shown by the accompanying reproduction of the blank. The other billing is done in accordance with the ordinary methods.

So much for the eastbound traffic. For the westbound work conditions are quite different. There are some loaded cars passing through the yard in the regular through western traffic, but the great bulk of the tonnage in this direction consists of empties; and, for this, special arrangements have to be made in order to meet the requirements of the several operations for cars. The loaded cars are sent through the yard in the regular way as specified in the



Mine Tag for Coal to Bluefield; Norfolk & Western.

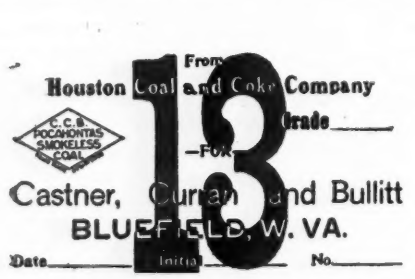


Mining Tags, Thacker Field; Norfolk & Western.

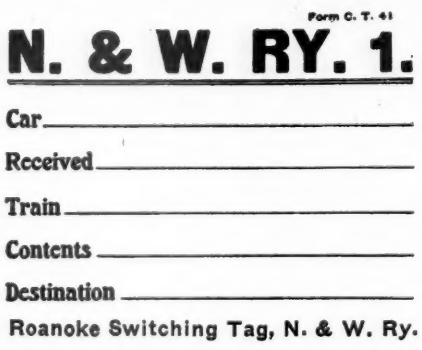
are accordingly entered in the same order from which the tare weights are subtracted, giving the net load. With this all the information is at hand for making out the waybills, which is accordingly done and a copy sent to the agents. This is the first and only information that the agent has of the weight of coal in the cars. The railroad company weighs the coal and gives the record to the shipping agent. In this way it has a check on the weights entered on the waybill, and the operator and agent is freed from the expense and trouble of weighing.

As soon as the cars have been dropped down upon the classification tracks they are made up into trains and pulled out. The time is usually too short to make up the individual waybills for each car, and the destination list only is, therefore, given to the conductor, and the waybills are forwarded by passenger train as soon as they can be made out. An exception to this is made in the case of cars destined for the Winston-Salem branch. There is a somewhat heavy business in southern shipments and the movement of solid trains is rapid. For these consignments a combined interline card and revenue waybill is made out. The original is written on thin, white paper and sent to the auditor, and a carbon copy made on a stiff card similar to that used on the switch list both in quality and size. This carbon copy is given to the conductor and serves as the revenue waybill.

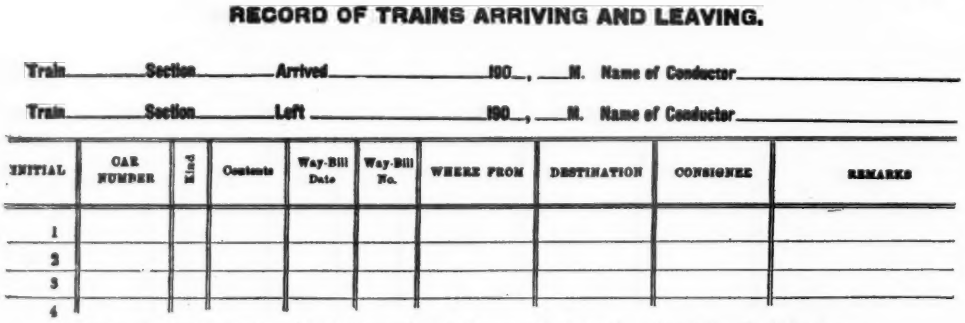
Owing to the fact that there are but few shippers in comparison with the number of cars forwarded, special waybills are printed



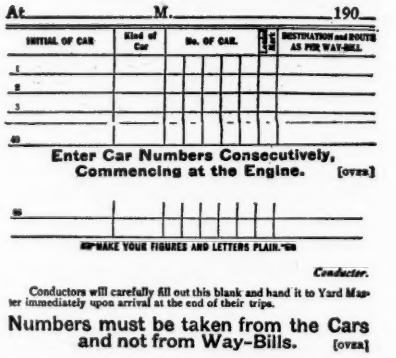
Mine Tag Card to Bluefield; N. & W. Ry.



Roanoke Switching Tag, N. & W. Ry.



Train Record Book (Old Form) Portsmouth Yard; Norfolk & Western.


Form C. T. 44
Norfolk & Western Railway Co.
SWITCH LIST
FOR
DIVISION.
Section of Train No.
Arriving at
At M. 190
INITIAL OF CAR
Kind of Car
No. OF CAR.
Loads
Empty
DESTINATION and ROUTE AS PER WAY-BILL
Enter Car Numbers Consecutively, Commencing at the Engine. [over]
MAKE YOUR FIGURES AND LETTERS PLAIN.
Conductor.
Conductors will carefully fill out this blank and hand it to Yard Master immediately upon arrival at the end of their trips.
Numbers must be taken from the Cars and not from Way-Bills. [over]

Switch List Card; N. & W.

originated in the early days of the industry and has held until the present.

Under these methods the car distributor at Bluefield allots the number of cars that are available from day to day. Trains are made up and despatched as rapidly as the cars come in and are sent out for car distribution along the line. The consignment of the cars to the mines is made on the basis of car tonnage capacity. During the night trains are made up for despatching in the early hours of the morning for the supply of those operations located on spurs that leave the main line near Bluefield, such as those to Pocahontas or Bramwell and Goodwill. These are regularly assigned trains and the crew makes the round trip distributing the empties and collecting the loads that are then hauled into Bluefield

for billing and consignment. Bluefield is the regular classification and shipping yard for all eastbound traffic as is Williamson for the westbound.

The actual number of empties that will be available for daily distribution cannot be known in advance for any length of time, but reports are received at the office of the superintendent of transportation at Roanoke, who informs the distribution agent at Bluefield of the probable number of cars that will be available for each 24 hours, based upon the location of the cars and the ordinary handling of the traffic. This information includes, not only the approximate number of cars that will reach the district from the east, but also from Portsmouth and the west, together with detailed information as to the makeup of each train when it leaves Radford, 62 miles east, so that the switch list for the classification of the cars can be made up by the time the train reaches the yard. statement of excess and shortage of the prorata delivery is kept so that the matter can be fairly adjusted from day to day in the distribution of the cars. The data thus collected and compiled serves as the basis for a daily report on the general situation that is made at 7 a. m. to the office of the superintendent of transportation at Roanoke. The physical operation of the yard has been handled in detail elsewhere.

WILLIAMSON YARD.

At Williamson, the next large yard west of Bluefield, the conditions are somewhat different, and there is of necessity a variation in the practice of keeping the car records. In the first place, the Williamson yard is made subordinate to that of Bluefield in the matter of eastbound shipments. All orders for car distribution are received from Bluefield and all eastbound loads, originating in the Williamson district, are sent to Bluefield under the operation tag

Form A. D 58 B.

NORFOLK & WESTERN RAILWAY CO.

Interline Card and Revenue Way-Bill for Coal or Coke.

Car No. _____

Contents (Kind of Coal or Coke) _____

W. B. No. _____ Date _____

Billed from _____ Mine No. _____

Billed to _____

Via _____ R. R. to _____

" _____ " " _____

" _____ " " _____

" _____ " " _____

Consignor _____

Consignee _____

Final Destination _____

SCALE WEIGHT	RATE AND DIVISIONS
At	
Cats	
Gross	
Tare	
Net	
Minimum	

FREIGHT	ADVANCES	PREPAID	COLLECT	Prepaid Beyond

RECEIVING AGENT WILL NOTE THAT THIS IS THE ONLY WAY-BILL THAT WILL BE ISSUED FOR THIS CAR:

TRANSPORTATION INFORMATION.

Transferred to _____ Car No. _____

At _____ Date _____

Weight of Car and Contents _____ Net Tons

Marked Capacity of Car _____ Lbs.

Conductors moving this Car must fill in record of same below.

TRAIN No.	CAR	Date 190	TIME
	Left		M
	Ar'd at		M
	Conductor.		

If load is transferred, or car is left short of destination, or delayed, state reasons therefor under head of remarks.

REMARKS:

Interline Card and Revenue Waybill (Bluefield); Norfolk & Western.

Car No. _____

To _____

Via _____

Contents _____

Norfolk & Western Railway Co.

CARD WAY-BILL.

FORM A. D. 58

W. B. No. _____ Date _____ 190__

From _____

Consignor _____

Consignee _____

Destination _____

Via _____

Prepaid, $	Collect, $
Estimated Weight	Actual Weight
	Gross
Where Weighed	
	Tare
190__	Net

Transferred to _____ Car No. _____

At _____ 190__

The regular Way-Bills for this Car have been forwarded by Passenger Train to Agent

At _____ Station

Conductors will fill out each space on back of this Card and the last one handling it at final destination will turn same over to Agent at that point for file.

Transportation Information.

Weight of Car and Contents { _____ Net Tons.

Conductors moving this Car must fill in record of same below.

TRAIN NO	CAR	DATE 190	TIME
	Left		M
	Ar'd at		M
	Conductor.		
TRAIN NO.	Left		M
	Ar'd at		M
	Conductor.		

If left short of destination, or delayed, state why.

Card Waybill Portsmouth Yard; Norfolk & Western.

Form A. D. 58-N.

Norfolk & Western Railroad Co.

Accounting Department.

LOCAL CARD WAY-BILL

FROM

BLUEFIELD

TO

Lambert Point

Way-Bill No.	Car Owner N. & W	Car Number
Lading COAL	Rate	Freight
Expenses	Prepaid	To Collect

Consignor, } Castner Curran & Bullitt.
Consignee, }

Way-Bill Weight	Scale Weight

_____ 190 _____ Agent.

Transportation Information.

Weight of Car and Contents } _____ Net Tons.

Special Card Waybill (Bluefield Yard); Norfolk & Western Ry.

C. R. No.

Norfolk and Western Railway Company.

COAL FIELD, FREIGHT TRAIN CAR REPORT

_____ DIVISION. _____ WARD.

DATE _____ 190__

ENGINES.	NUMBERS	FROM	TO	ENGINEER

Tonnage Out of Initial Point _____ Tons.

Tonnage at End of Run _____ Tons.

_____ Conductor.

	INITIALS	SIZE	NUMBERS	LOAD-ED COAL	MOVEMENT FROM	MOVEMENT TO	TIME TAKEN	TIME LEFT
1								
2								
3								
34								
35								

B.—Box. F.—Flat. C.—Coke.
S. D.—Single-Deck Stock. H.—Hopper Gondola. S.—Side Dump.
D. D.—Double-Deck Stock. G.—Gondola.

Train Car Report (Williamson Yard), Norfolk & Western.

The cars may fall short or exceed these figures according as the traffic is expedited or delayed. This includes all of the cars to be distributed throughout the whole of the coal region, whether that distribution be made from Bluefield, Williamson or Portsmouth, so that the whole matter is in the hands of one man.

This car distributing agent also keeps a daily record of the number of empty cars delivered to and the number of loads taken away from each operation. In this way the condition of the sidings at those points can be ascertained at any time. With the variation in the number of cars available as compared with the probable number as reported from Roanoke, it also happens that the distribution cannot be made in strict accordance with the classification of the operations that has been alluded to. For this reason a daily for weighing and definite consignment. Williamson, too, is somewhat differently situated from Bluefield. The latter place is located to the eastward of the coal fields and there is almost no coal traffic originating to the eastward of it, while Williamson stands in the heart of the Thacker field, and must not only distribute cars in, but receives coal from both directions. Further than this, consignments of loaded cars pass through it, not only from the Thacker district, but also from the Tug river and Pocahontas districts that are located farther to the east.

Coal is also shipped under somewhat different conditions from the Thacker field than from the Pocahontas. Attention has been called to the fact that, in the Pocahontas field, the cars are loaded at the operations and tagged in a way that practically consigns

them to the representative shipping agents at Bluefield and these then give the shipping directions to the yard. In the Thacker district the same system is followed as far, as the making out of the waybills is concerned, but the coal is, for the most part, tagged for destination at the tipple and billed at Williamson, as very few of the operations maintain shipping agents at that place.

For this purpose a somewhat different form of car tag is used. It gives the consignee and destination, usually the routing, the grade of coal, date and car initial and number. Some call for the weights, but as this cannot be added at the tipple, and is not usually put on at the weigh office, it does not appear thereon. The tags also do not usually bear the operation number, though each one is numbered and is recorded as such in the weigh office. In fact, there is no uniformity in size, color or make-up of these tags, each one having evidently been designed by the user to meet his own peculiar ideas, the one requirement being that blank spaces shall be provided whereon to convey the information required in order to make an intelligent billing.

NORFOLK AND WESTERN RAILWAY COMPANY.

WEIGHMASTER'S RECORD OF COAL AND COKE WEIGHED AT _____ SCALES.

Day of Month 190		CAR Initial	CAR Number	Grade	From Mine No	Series	Manifest No.	CONSIGNEE	DESTINATION	Route Via	Light Weight of Car	Gross Weight of Lading	NET WEIGHT	N. & W. Net Freight	REMARKS
	1														
	2														
	3														
	4														
	5														
	6														
														7	

Weighmaster's Record (Williamson and Bluefield); Norfolk & Western.

As the cars are dropped down over the scales the gross weight is taken and this, in connection with the tare that the messenger has noted on the tag, makes it possible to fill out the record book No. 153, which forms the basis from which the general movement is known. These are the only two permanent records that are kept aside from the tissue copies of the waybills. Of course, in the matter of the train records, they are made complete for both arriving and departing trains, and in order to facilitate a search when such action is needed. In the case of an arriving train those cars that pass through with it are written in with black ink, while those that are dropped are written in red. On the other hand, for departing trains those cars that passed through the yard with the train are written in in black and those that were picked up are added in red. These are usually cars of a given classification that operating conditions make desirable to forward together and which cars and cars for local delivery between Williamson and Portsmouth are made up in station order for such delivery in the usual manner.

For the eastbound work there are simply the local deliveries of loads and empties for the sparsely settled territory between Williamson and Bluefield and through freight which is sent unbroken to Bluefield to be classified there as already stated. In the case of the empties these are sent to mines east of Williamson for coal and coke loading. In the collection of the traffic an effort is made to avoid doubling back on the haulage as much as possible and, as westbound billing for loads originating west of Williamson is not done at this point, these cars are collected at Nolan, eight miles west and taken from there to Portsmouth with no other billing than the car tag attached at the mine. At the same time all the eastbound loads are hauled to Williamson, where they are simply sent on to Bluefield without either weighing or billing. In this way this yard is relieved of all weighing and billing of all loads originating to the west. Where cars come in from the east, as is the case at Bluefield, the destination orders are received from the home office of the operations, and this may be located at Columbus, Bluefield or Roanoke. On the other hand, all westbound traffic that originates to the east of Williamson is weighed and billed at that point as at Bluefield. And this is done very rapidly.

As for the records they are very simple, complete and clear. When a train arrives a messenger from the weighing office goes down the line and removes the tags from the cars, checking off the numbers, adding the tare weight and keeping them in order. In addition to these the conductor turns in a train car report made up on the blank 10½ or 10, which furnish the car record office all the information needed as to the movement of each car up to the time of its arrival at Williamson. Blank 10½ is used only in the coal fields. From this the car tags, the waybills, and the switch list, similar to that used at Bluefield, are made up, and this is done and ready for delivery to the yard conductor by the time the train has been inspected.

Form A. D. 5½ B.

NORFOLK & WESTERN RAILWAY COMPANY.

No. of Way-Bill _____

WAY-BILL FROM BLUEFIELD TO LAMBERT POINT. _____ 190__

No. of Car _____

CONSIGNOR	CONSIGNEE	DESCRIPTION OF LADING	BLUEFIELD SCALE WEIGHT	
			ACTUAL WEIGHT	
Castner, Curran & Bullitt,	Castner, Curran & Bullitt,	1 Car Run of Mine Coal.	Gross _____	Freight Charges Settled Through Auditor of Receipts' Office.
Mine No.			Light _____	
			Net _____	

This Way-Bill to be forwarded to Agent, Lambert Point, by first passenger train; and first impression copy to Auditor of Receipts' Office, Roanoke.

Special Waybill, Bluefield Yard; Norfolk & Western.

It will be seen that in these two great yards of the Norfolk & Western coal traffic, the methods of handling the work are exceedingly simple and expeditious. This simplicity is, of course, possible because of the fact that between the two yards there are no complications of foreign connections to be considered, and everything in the way of a loaded car that comes into Bluefield from the east goes, with a few exceptions, through to Williamson, while those reaching Williamson from the west go on to Bluefield, the only exceptions being those intended for way delivery, which are handled by the local freight. Empty cars, on the other hand, on reaching either yard are ordered to some coal operation for loading.

Having now considered the methods employed at the two originating yards, we can turn to the large distributing yards at Portsmouth, Ohio and at Roanoke, Va.

PORTSMOUTH YARD.

Taking Portsmouth first; we have here an entirely different set of conditions from those existing in the two yards that have been

1	2	3	4	5	6	7	8	9	0
			N&W 84 DEC. 10.06	B&M 29 DEC. 13.06					
			35624 92 - 11.06	30265 B&O DEC. 13.06					

Car Record Book, Portsmouth Yard; Norfolk & Western.

considered. At Bluefield and Williamson there is a large originating tonnage. At Portsmouth there is very little originating and even that has been filtered through the small collecting yards at Nolan and Naugatuck, where a primary billing has been done. The billing is put on a card waybill of the form shown and this card follows the car through to destination, the conductor filling out blanks on the back in which there are spaces for the recording of eight train movements, with the date and hour of departure and arrival of each train. These cards, with the regular waybills, form a complete set of waybills with all of the information as to car initial, number, loading and destination that is usually carried by such a document. Regular waybills are, however, made out from the cards, which cover only those cars that have been loaded with coal west of Williamson and are sent on to Portsmouth with the car tags in position. The tags are then removed at that place and

FORM A. D. 134. SMALL.

NORFOLK AND WESTERN RAILWAY CO. Line Initial ____ Road Initial ____ Car No. ____ W. B. No. ____

INTER-LINE WAY-BILL FROM ____ TO ____ DATE ____ 190__

ROUTE VIA ____ Transferred Into { INITIAL ____ No. ____ AT ____ 190__ / INITIAL ____ No. ____ AT ____ 190__

THROUGH RATES

1	2	3	4	5	6	Special

Consignor	Consignee and Destination	Number and Description of Articles	Weight	Divis's of Rates	Freight	Advances	Prepaid	Total	Proportion	Proportion	TOTAL To ____

Interline Waybill.

the cars weighed and the weights, including the gross, tare and net, are sent to the owners.

Having waybills for his whole train the conductor is able to make out a switch list on form 56 before reaching Portsmouth, so that the work of reclassification can be begun as soon as the cars have been inspected. As the cars to be weighed are given on the card bills from Nolan or Naugatuck, trains containing them are run in on a special track so that they may be readily handled. They are then pulled out, weighed and thrown back upon the proper classification track, and this classification is facilitated by the mine tags from which the switch list can be checked. It may be added here that the switch list No. 10½, as used in the Pocahontas and Thacker fields, is always turned in to the yardmaster's office for record and use in the scale office. This can readily be done, as the number of "weighers," as they are called, are few in comparison with the total number of cars handled through the yard. For example, in October last, 39,899 cars were passed through the yard, and of these 1,323 were weighed. In November 39,077 cars were handled, of which 1,477 were weighed. This gives an average of about 1,147 cars per day, of which about 46 were weighed. So that provision has to be made for handling less than 50 weigh cars a day.

As there are no connection for interchange at Portsmouth, with the exception of that with the Baltimore & Ohio, the records kept are of the simplest character.

Up to the first of January, 1907, two books contained all the records that were filed other than the tissue copies of the waybills that were issued. These were two books of form C. R. 9. One contained a train list of all arrivals regardless of direction and the other of all departures. It was made up from the conductors' switch lists and the waybills. It was complete, but individual cars were so hidden in it that it was difficult to trace one through the yard. Sometimes hours would be required to trace the movement of a single car, or to ascertain that it had ever reached Portsmouth. Accordingly, on January 1, a new book was opened in which the record of the car movement is reduced to the acme of simplicity. The ruling and the record is substantially as given in the accompanying illustration. This book is to be worked in sections of nine pages each. The page number represents the first figure of the car number, and the column number the last figure. In the sample we have page 3, so that all cars listed on that page would have 3 for the first figure, while the entry would be made in the column corresponding to the last figure. Suppose, then, a call were to be made for a Norfolk & Western car No. 35,624. Turning to page 3 and column 4, it would be seen that the car was received on train 84, Dec. 10, 1906, and despatched on train 92, Dec. 11. A call for Boston & Maine car, 30,265, shows it to have been received on train 29, Dec. 13, 1906, and delivered to the Baltimore & Ohio on the same date. As a further precaution a supplementary train list is made out on the switch list blank (C. R. 56). After a train has been made up, and before it leaves the yard a messenger goes down the side of it and enters the initial number and kind of car in the proper columns. On turning this list in to the office, the destinations are entered from the waybills. These cards are then filed away as a possible means of assistance in looking for a lost car, though they are rarely referred to.

The Portsmouth yard forwards eastbound cars classified and shipped solid for Williamson, to which point the heavy class W locomotives are rated to haul 1,000 tons. As the line for the first part of the run to Kenova is straight and level the tonnage rating is 2,200 tons; from Kenova a helping engine is used.

For the westbound traffic the road has two branches, one to Columbus and the other to Cincinnati. For Columbus and the Hocking Valley connection the trains are classified and sent out solid, as are all other loads to Circleville, Chillicothe, Glen Jean and Bannon. The locals are, of course, made up in station order. Trains are also made up solid for Cincinnati.

Form A. D. 133—SMALL.

NORFOLK AND WESTERN RAILWAY CO.

ORIGINAL CAR.
Ini. ____
No. ____
POINT OF TRANSFER ____

CAR { INITIAL ____ NUMBER ____ | WAY-BILL No. ____ DATE ____ 190__

WAY-BILL ____ to ____ for ____ via ____

CONSIGNOR	Consignee and Final Destination	Number and Description of Packages	Marks	Weight	Class	Rate	N. & W. Net Freight	Charges	N. & W. Prepaid	Total to Collect at ____	Proportions of Other Lines		Prepaid Beyond

This Way-Bill to be used only for Freight destined for points beyond the line of the N. & W. Ry.

Waybill; Norfolk & Western.

It will thus be seen that the work of the Portsmouth yard is exceedingly simple and the records and work of the yardmaster's office are reduced to a minimum, and yet they contain all of the information that is needed at a division terminal that is purely a receiving and despatching point, and where no account is taken of demurrage or car accounting. For this the single book suffices.

ROANOKE YARD.

At the Roanoke yard there is a somewhat greater complication than at either of the other points taken up owing to the fact that it is the junction point of four divisions. The main through

line from east to west there crosses the north and south road running from Hagerstown, Md., to Winston-Salem, N. C., so that there is a wider range of classification and more general breaking up of the trains than at any of the other yards. In the matter of records they are kept along practically the same lines as those used at Portsmouth previous to January 1. The traffic entering the yard differs from that of the other three points in that every car is properly billed at or near its starting point. Unlike the traffic originating in the Pocahontas and Thacker districts, that originating east of Bluefield is weighed and billed before reaching Roanoke, with the exception of an occasional stray car that may have been picked up between scale points. But these exceptions play no part of any importance in the general scheme of the yard operation. The permanent yard records are kept in books printed in the C. R. 9 form, and of these there are two for each division, one for arriving and the other for departing trains. That is to

Form A. D. 3½ F.

Norfolk and Western Railway Company.

No. of Way-Bill.....
No. of Car .....

COAL WAY-BILL from..... to 190

Consignor.	Consignee and Destination.	Description of Lading.	.....Scale Weight.	Rate per Gross Ton.	N. & W. Net Freight		Charges.		Prepaid (N. & W. Proportion only.)		Total Freight and Charges.								Prepaid on Account of Other Lines.	
					Dlls.	Cts	Dlls.	Cts	Dlls.	Cts	Dlls.	Cts	Dlls.	Cts	Dlls.	Cts	Dlls.	Cts	Dlls.	Cts
			ACTUAL WEIGHT.																	
		One Car COAL	Gross.....																	
Mine No.			Light.....																	
			Net.....																	

Coal Waybill; Norfolk & Western.

say, there are six in all, two for the line west, to Radford, Bristol and Bluefield, two to the lines east, to Norfolk, and two for the single division running through from Hagerstown to Winston-Salem. These records are compiled from the switch list, made out by the conductor, and the waybills.

In the matter of the handling of the cars for switching a novelty is used in the form of a Roanoke yard tag. The form of this tag is reproduced and on it is entered all of the information needed for the handling of the car through the yard. These tags are filled out by a messenger who does the work from the waybills as soon as they are handed in by the conductor, and then goes down the train fastening each one in place by tacks, so that by the time the train has been inspected on the receiving tracks the

by rain and the labor involved in applying it is no more. Two messengers, one for day and the other for night service do all of the work, and this covers about 4,600 cars per day.

When a train has been made up, the conductor's car report is made out from the waybills and the list of cars in that train as brought in by a messenger. The bill is put on form C. R. 10 and is laid over the proper page of the outgoing book with a carbon sheet between so that the book contains an exact duplicate of the sheet given to the conductor and the time needed for a second copying is saved. The conductor makes the proper notations on the original as to where cars are dropped and turns the original in to the card record office.

There is, of course, a daily checking of the cars on the repair tracks for the information of the yardmaster, and a report of all movements is filed every morning at six o'clock.

The classifications, used for the Norfolk division, are for locals in station order to Lynchburg, Lynchburg and beyond, to Crewe, Crewe and beyond to Petersburg, and Lambert's Point. Going west cars are classified to Bluefield and Radford. In the locals no attempt is made at station order arrangement, the only thing being to keep the air cars in front. In fact, the classifications followed are merely those of junction points and local trains are obliged to do their own switching on the road.

It has been seen that in the classification at Bluefield, there is one for tidewater coal destined for Lambert's Point. These trains are sent through in block and are not switched on to the classification tracks at all. They are simply held in the receiving yard for inspection, where the bad-order cars are cut out and the train then sent down on to the forwarding track. The same method

Form A. D. 3½ E.

Norfolk and Western Railway Company.

No. of Way-Bill.....
Car No. .....

COAL WAY-BILL from..... to 190

CONSIGNOR	CONSIGNEE AND DESTINATION	DESCRIPTION OF LADING	WEIGHT as per SCALES	Rate per Gross Ton	N. & W. NET FREIGHT		
					Doll.	Ct.	
			ACTUAL WEIGHT.				
		1 Car Coal.	Gross.....				Freight Charges Settled Through Auditor of Receipts' Office.
Mine No.			Light.....				
			NET.....				

Coal Waybill; Norfolk & Western.

switching for classification can be begun. The men work entirely by these tags and it is thus impossible for a car to be lost for, no matter where it may be in the yard, it bears its own destination and it is never necessary to ask any questions or search through a mass of waybills in order to determine the disposition of a car. This system is also especially valuable in the matter of bad order cars. Where these are set in on the repair tracks, the tag carries the lading mark, so that if it is perishable the repairmen go to work on it at once without further instructions. With the tags in position there is never any necessity for further references to the waybills until the car is in the train and ready to be pulled out, so that these can be kept and classified in pigeon holes just as the cars are upon the tracks. The tag has the further advantage over the usual method of chalking in that it cannot be washed out

is pursued for westbound strings of empties. In this way a train is sent on through without obstructing the yard at all and with little or no delay. Such trains are usually made ready for despatching within 45 minutes of the time of their arrival and the engine and crew for hauling them are ordered in advance. The time required for the classification of an ordinary train of 50 cars is about 45 minutes and trains can be inspected, put through the yard and made ready for despatching in about an hour and a half.

Trains entering the yard from the west are simply run in on the receiving tracks in the usual manner, but from the north, south and east they are held outside until ordered in. These three branches come together east of the passenger station, and back on the Y is a telephone station connecting with the interlocking signal tower. As soon as a train reaches this point the conductor tele-

phones the fact to the towerman, who, in turn, informs the assistant yardmaster at the east end of the yard. The latter is thus enabled to regulate the entrance of trains and admit the trains most desirable to handle at the time. If the trains were allowed entrance in the order of, and as rapidly as they arrive, it might happen that the yard could be congested with the number of trains of empties that had arrived in quick succession, while one loaded with perishable freight would be held back. It involves the possible holding of some of the crews for overtime, though this seldom occurs, but it does give the yardmaster a complete control of the situation.

TRAIN CAR REPORT—SHOWING RECORD AND TONNAGE OF CARS AND THEIR SEAL RECORD.

Form C. R. 10.

_____ Division _____ Freight (Class of Train), _____ ward. Date _____ 190__

Conductor A	Train No.	Where From	Schedule Leaving Time	Actual Leaving Time	Where To	Schedule Arriving Time	Actual Arriving Time	Engine Movements: Enginemen	Firemen	Eng. No.	From	To	Time Called to Report	Time Relieved	Hours and Mins. in Service: Hours	Mins.
A	B	C	D	F	G	H	J	K	KA	M	N	Q	R	S	U	V
													____M.	____M.		
													Schedule Cost for Moving the Train			
													Actual Cost for Moving the Train			

"P" Passenger, "E" Emigrant, "A" Baggage, "R" Postal, "X" Express, "N" Combination "J" Private, "M" M. of Way, "C" Cable, "S" Box, "S D" Single Deck Stock, "D D" Double Deck Stock, "Po" Poultry, "F" Flat, "G" Gondola, "H" Hopper, "O" Coke, "D" Coal Dump, "T" Tank, "D F" Dead Engine.

	Initial or Line of Car	Kind	Number of Loaded Car	Contents of Loaded or Number of Empt Car	Taken at Station Number	Left at Station Number	Check	Time Taken	Time Left	Billed to Station Name or No.	Light Weight of Car	Weight of Contents of Car	Seal and Fastening Record: Seal "R" Door	Seal "L" Door	End Door "L"	End Door "L"
	A B	A C	A D	A F	A G	A H	A I	A J	A K	A M	A N	A R	A V	A W	A X	A Z
1																
2																
3																
79																
80																
	Total,		_____ Loads	_____ Empty												

Certified Tonnage Out of Initial Point _____ 1000 Pounds _____ Agent or Yardmaster.

Certified Tonnage at End of Run _____ 1000 Pounds _____ Agent or Yardmaster.

Correct _____ Conductor.

Total Weight of Train ("A N and A R") _____ Tons "B B" Per Cent. of Total Capacity in Lading _____ Per Cent., "B C" Total Tons Hauled One Mile _____ Loaded _____ Empty.

WEATHER REPORT.

By Forwarding Agent or Yardmaster.

Temperature ____ Above ____ Below ____ Wind ____ Storm

Temperature ____ Above ____ Below ____ Wind ____ Storm

By Conductor. In Transit.

Temperature ____ Above ____ Below ____ Wind ____ Storm

Temperature ____ Above ____ Below ____ Wind ____ Storm

The Following Schedule of Tare Weight will be Used Where Cars Are Not Stenciled:

Box, 28 foot ..... 22,000 lbs.	Flat, 33 foot ..... 24,000 lbs.	Gondolas, Hopper Bottom, 26 ft. 21,000 lbs.	Empty Tank Cars ..... 28,000 lbs.
Box, 31 foot ..... 25,000 lbs.	Flat, 34 foot ..... 18,000 lbs.	Gondolas, Hopper, Bottom, 28 ft. 27,000 lbs.	Derrick Cars, complete. ... 50,000 lbs.
Box, 34 foot ..... 25,000 lbs.	Flat, 34 foot 3¼ inch. ... 21,000 lbs.	Gondolas, Hopper Bottom, 27 ft. 7¾ inch. ..... 29,000 lbs.	Postal Cards ..... 50,000 lbs.
Box, 36 foot ..... 29,000 lbs.	Flat, 34 foot 6 inch. ..... 18,000 lbs.	Gondolas, Hopper Bottom, 35 ft. 21,000 lbs.	Officers' Cars, 1, 2, and 3 .. 86,000 lbs.
Stock, 34 foot ..... 22,000 lbs.	Flat, 36 foot ..... 28,000 lbs.	Refrigerator Cars. ..... 33,000 lbs.	Other Officers' Cars ..... 56,000 lbs.
Stock, 36 foot ..... 25,000 lbs.	Charcoal Cars. ..... 23,000 lbs.	Patent Stock Cars. ..... 26,000 lbs.	Coaches ..... 54,000 lbs.
Stock, 36 foot 2½ inch. ... 28,000 lbs.	Gondolas, Drop End, 35 foot. 23,000 lbs.		Combined Cars ..... 46,000 lbs.
Poultry Car ..... 33,000 lbs.	Gondolas, Drop End, 36 foot. 26,000 lbs.		Baggage and Express Cars.. 50,000 lbs.
Flat, 31 foot ..... 18,000 lbs.	Coke Racks, 35 foot ..... 24,000 lbs.		Sleepers ..... 90,000 lbs.
	Side Dump Cars, 29 ft. 4 in. 23,000 lbs.		

INSTRUCTIONS TO AGENTS AND YARDMASTERS.

Agent or Yardmaster at initial point of train will make out and deliver this report to Conductor before departure of train, giving all information called for by headings "Date," "B" "C" "D" "A B" "A C" "A D" "A F" "A G" "A M" "A N" and "A R," also foot columns "A D" "A F" and "A R," placing totals at foot of column with lead pencil. If weight is not stenciled on car, use weight as per schedule above. In computing weights under column "A N" and "A R" be governed as follows: All pounds between 0 and 500 will be dropped, and between 500 and 1,000 pounds to be considered 1,000 pounds. In the case of cars used as way-cars in the train, an arbirarty weight of 5,000 pounds will be used. Agents or Yardmasters must certify to tonnage and seal record of train at time of leaving terminals. Agents, in making weather report, will give temperature, direction of wind, if light or strong, whether raining or snowing, cloudy or clear.

Agents or Yardmaster at end of train run will be handed this report by Conductor of train and must receipt for same in Conductor's train book, giving date and time received. After carefully comparing this report with the yard check of the train as to car numbers, seal record and with way-bills as to tonnage, agents will certify to tonnage in train when received, forwarding this report by first passenger train to Car Record Office, Roanoke, Va.

INSTRUCTIONS TO CONDUCTORS.

Conductors will complete this report as called for by headings "A" "K" "K A" "M" "F" "G" "H" "J" "N" "Q" "R" "S" "U" "V" "A J" "A H" "A K" "A V" "A W" "A X" and "A Z" adding to the report all cars picked up by his train after leaving initial point; giving all the information called for by all columns; also total footing of columns "A D" "A F" "A N" and "A R"; also certifying to correctness of tonnage in space provided above; report weather encountered on run in space provided, and hand this completed report to the Agent or Yardmaster at end of run and take receipt for same in train book. Under Seal and Fastening Record "R" will mean right door when going toward the engine. "L" left door. "F" front and door fastenings. "B" back and door fastenings.

Train Car Report (Williamson Yard); Norfolk & Western.

SOUTH NORFOLK YARD.

As will be inferred from the description of the South Norfolk yard the records at that point need be only of the simplest character. It is known that everything that comes into the yard is intended for a Norfolk delivery. It may be in the form of coal or coke for Lambert's Point or coal, coke or general merchandise for the city yards or a connecting line, but none of these deliveries are made at the yard itself. Hence the records need only show the arrival of a car and the date of its departure with its destination. For this purpose the record is kept in a book similar to form of it. The balance of the work consists merely in the yard movements that have already been described.

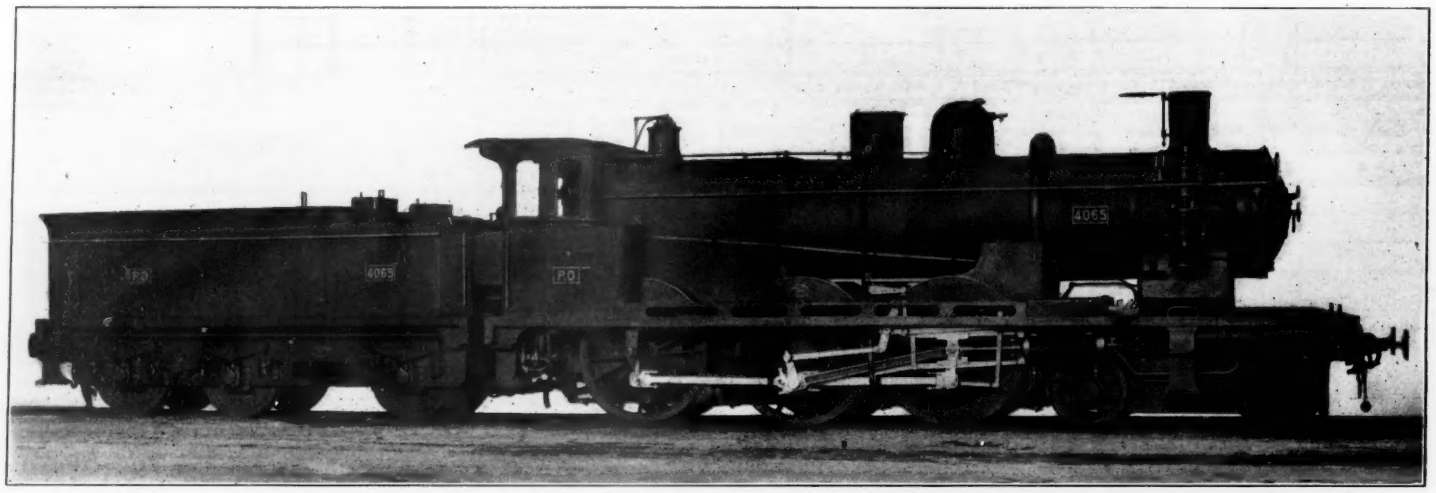
As in all large operations that are to be accomplished expeditiously the handling of cars through the yards and over the lines of a great railroad system must consist of simple movements that are not liable to delay or interruption. So in the case of the movement of coal and coke from the mines to the seaboard or the western markets, there is no doubling back on the route, but the traffic moves steadily forward from the tipple to the terminal with the minimum of clerical and switching attention. To pass the work in review the loaded cars are gathered and brought into the Bluefield yard, a miscellaneous assemblage of shipments from various mines and intended for destination lying at all points of the compass, but

mainly for the seaboard and the industrial plants in Virginia and the Carolinas. No sooner is such a train in the yard and before the car inspectors have finished their rounds, than the switch list is made out and order begins to come out of the confusion as the cars drop over the scales and in upon their proper tracks in the classification yard. Here the tidewater shipments are handled once for all and are sent forward with no breaking of bulk, with no delay for records or switching, and no need for a stop except for inspection at division points. They pass through and around the yards at Roanoke, Crewe and South Norfolk without interfering with or requiring switching and run direct to the terminal at Lambert's Point. Cars for other destinations are handled expeditiously and without back hauling, while the records of each yard are so kept that any and every car can be readily traced in its progress over the road. This means an economical handling and even this cost will probably be cut down when the yards are finished. At present the cost ranges at about 8½ cents at Portsmouth and 10 cents at Bluefield and Roanoke and this includes all of the expense of weighing and billing which does not usually fall to the share of the yard costs to the same extent that it does in this case where the volume of originating traffic is so large.

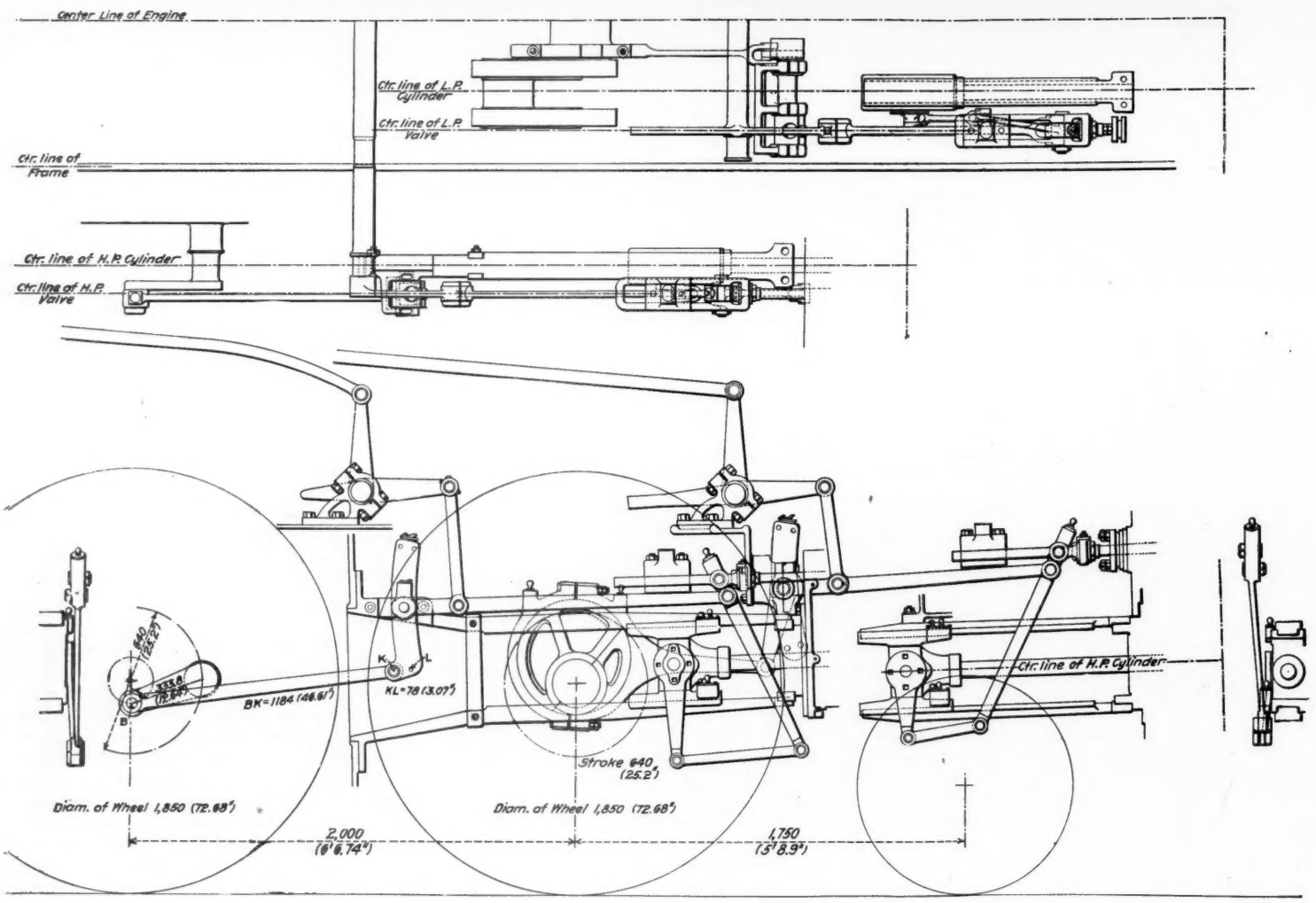
De Glehn Compound for the Paris-Orleans Railway.

The Baldwin Locomotive Works has recently built 20 ten-wheel locomotives for the Paris-Orleans Railway of France. These engines are compounded on the De Glehn system, and were built to drawings furnished by the railroad company. All measurements in their construction were made on the metric system, necessitating the introduction by the builders of many new standards and gages.

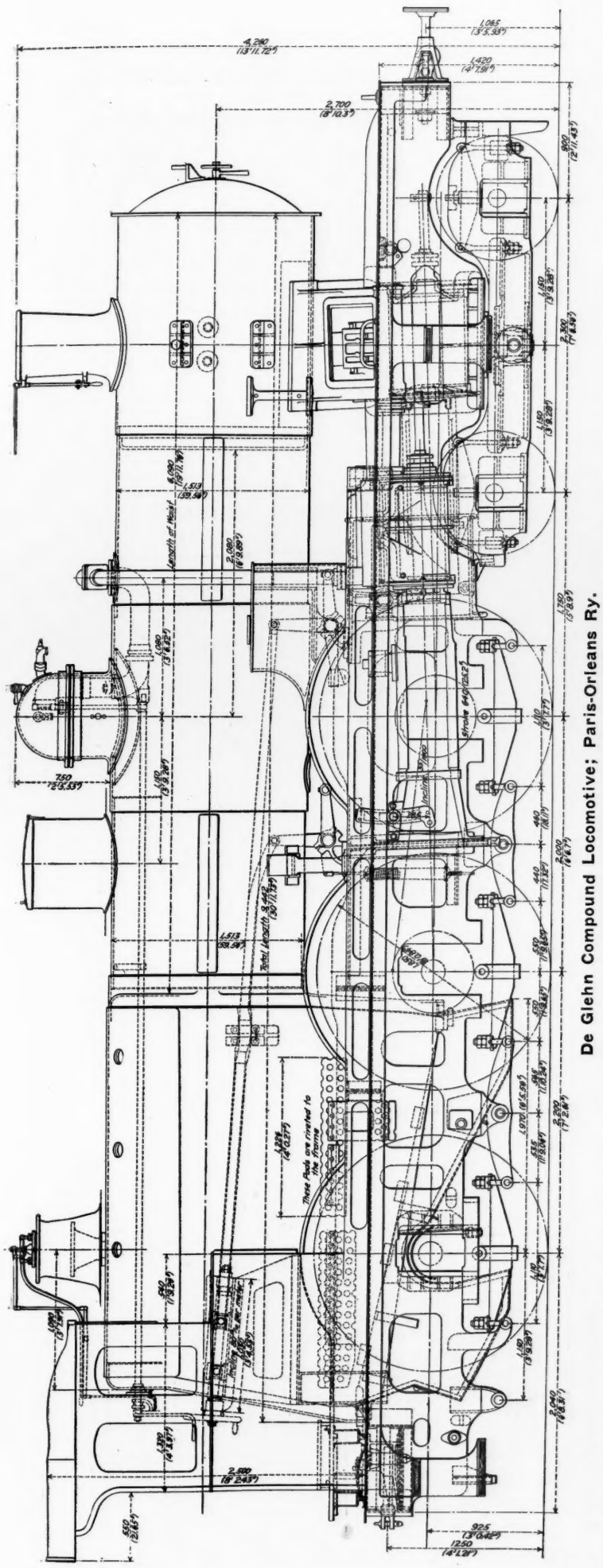
This statement is, in itself, full of significance, for one of the principal claims of the opponents to the introduction of the metric system in the United States has rested upon the assumption that its use would create endless confusion in shops where the whole organization and training of the men as well as all templates, drawings and tools are based upon the English system. Many engineers have in a small way had to do with the execution of work with the metric measurements, and have found no difficulty. But they were told that this was quite a different matter from the execution of large orders in regular manufacturing. Now an order for 20 locomotives while not large in view of present day practice, is by no means insignificant, and yet these engines were built from French drawings exclusively and entirely, and using the metric sys-



Locomotive Built by the Baldwin Locomotive Works for the Paris-Orleans Railway.



Valve Motion; De Glehn Compound Locomotive.



De Glehn Compound Locomotive; Paris-Orleans Ry.

tem of measurement in the shops. It was the first attempt at this in this country and was most successful. And what is more, the builders state that they liked the system and had not the slightest difficulty. It would seem from this that half the terrors of the mountain disappear as we begin to climb. These statements are offered merely to call attention to the conditions under which this order was executed. In sending the drawings into the shop the French terms were retained though in most cases the English translation was added, so that such expressions as *coupe par* and *vue d'arriere* abound. These drawings were complicated and intricate in their conception but thoroughly well executed.

In the reproduction of these drawings, the metric measurements are retained, and to these are added the English equivalents for the benefit of those who do not readily convert one to the other mentally.

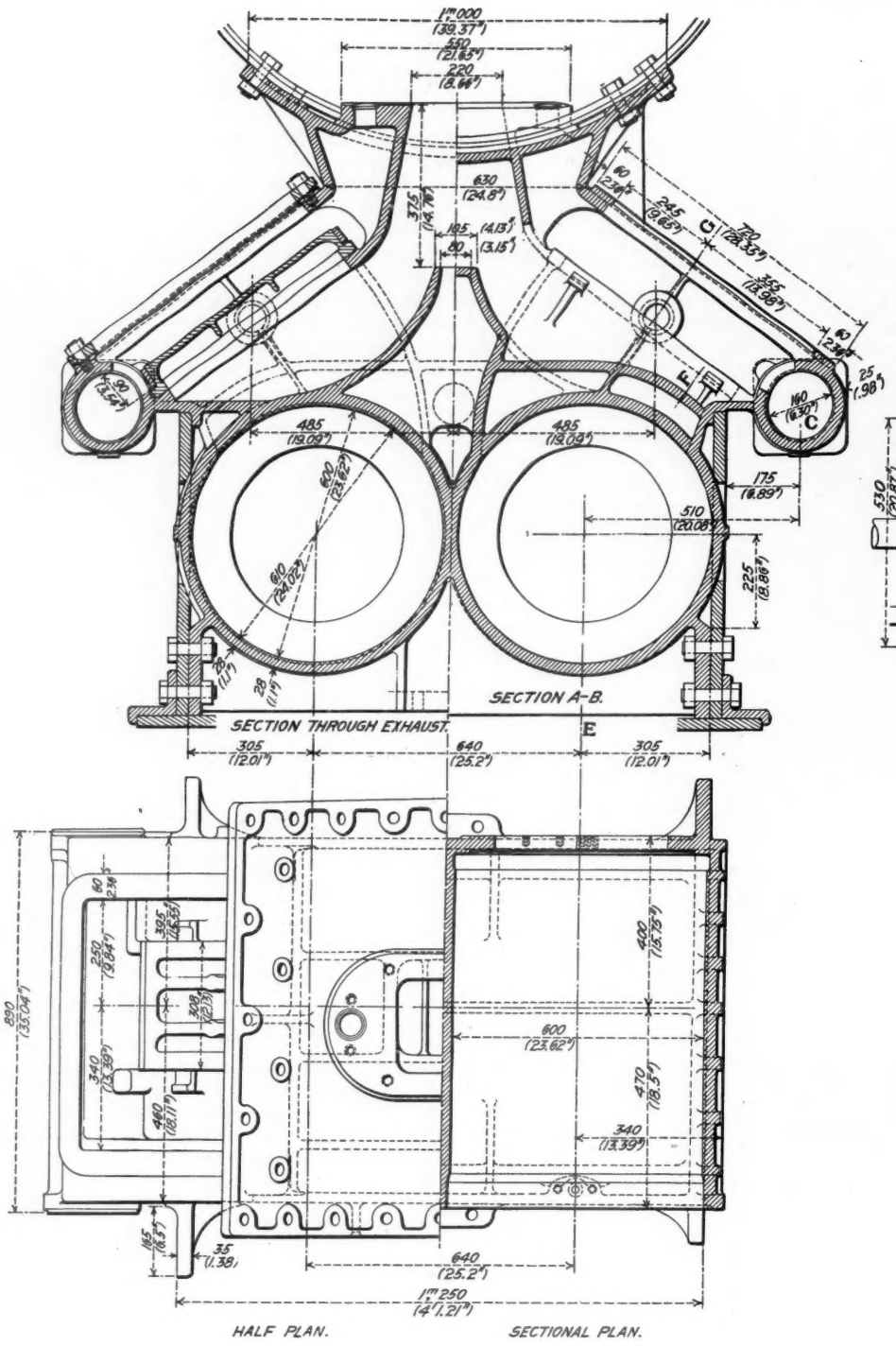
The De Glehn type of locomotive is characterized by an arrangement of cylinders which divides the application of the power between two driving axles, and provides a separate valve gear for each cylinder, so that the high and low-pressure cut-offs can be independently varied. The high-pressure cylinders are placed outside, while the low-pressure are inside between the frames. The Walschaerts valve motion is used throughout. The gears for the inside cylinders are driven from eccentrics placed on the first driving axle, while those for the outside cylinders are driven from the second pair of driving wheels by return cranks placed on the crank pins.

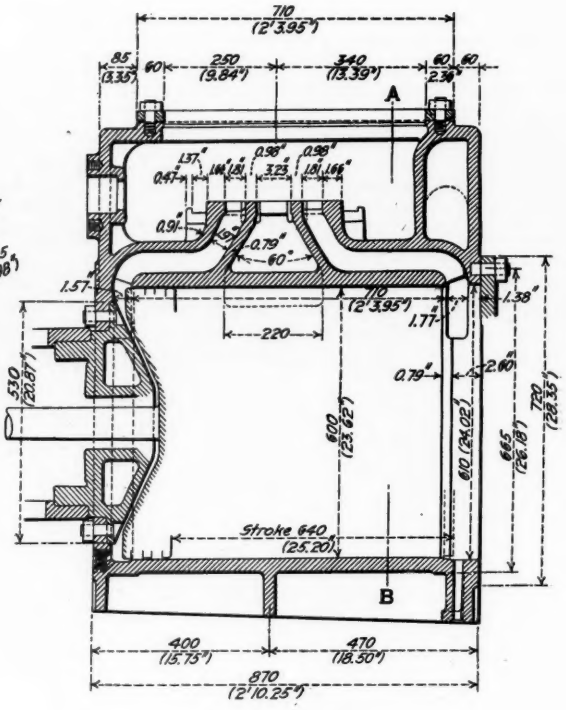
The outside, or high-pressure cylinders, are connected to the second pair of driving wheels, while the inside, or low-pressure, are connected to the first pair, which has a cranked axle. In order to keep the main rods of as nearly the same length and weight as possible, the high-pressure cylinders are set some distance in the rear of the low-pressure. This arrangement of cylinders is facilitated by the use of plate frames to which the cylinder castings are conveniently bolted. In the locomotive under notice, the high-pressure cylinders are located immediately in front of the leading pair of driving wheels. Each steam chest is cast in one piece with its corresponding cylinder. The slide valves are balanced, and are of bronze. Both the low-pressure cylinders are formed in one casting, the upper part of which constitutes a saddle for the support of the smokebox. The plate frames are cut out on each side, as the width over the low-pressure cylinders is greater than the distance between the frames. The low-pressure valves are also of bronze, but unbalanced; they have inclined seats, and their steam chests are formed within the cylinder casting. All the cylinders are set on an inclination of 3½ per cent., this being done to provide clearance for the engine truck under the low-pressure cylinders. Steam is conveyed to the high-pressure cylinders through external pipes, and is passed on to the low-pressure cylinders through special valves which are operated by air pressure controlled from the cab. These valves are in the form of sleeves, with suitable openings cut in them, and according to their position the engine may be operated as a compound or single-expansion locomotive.

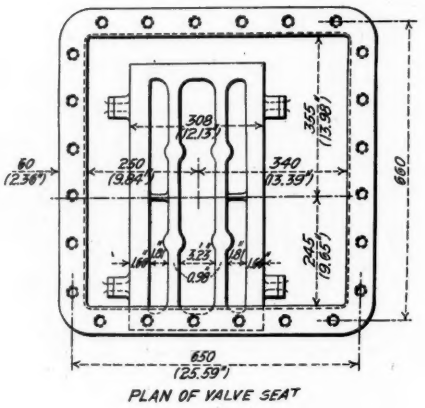
Thus tracing the flow of steam from the dome, it enters the high-pressure steam chest, from the outside pipes, at the top at A, and, after doing its work in that cylinder is exhausted at B, which is in line with the steam inlet at C of the low-pressure steam chest. From the low-pressure cylinder it passes to the exhaust. As will be seen from the ratios published at the end of this article, that existing between the high and low-pressure cylinder follows the trend of current practice and is higher than that prevailing a few years ago.

The guides are of forged steel and of the two-bar type. Those for the outside cylinders are braced by steel castings bolted to the frames, while the inside guides are secured to a heavy steel casting which braces the frames between the high-pressure cylinders, and also forms a support for the low-pressure links. The crossheads are of wrought-iron, case hardened. Forged steel main and side rods are used throughout, the outside main rods being of I-section. The side rod stubs are of a modified strap form, the bolts being in one piece with the straps. With this arrangement, the bolts are in tension instead of shear. The return cranks for the outside valve motions are forged in one piece with the crank pins, which are guided into their seats in the wheel centers by means of key ways. By placing the center lines of the high-pressure steam chests 120 m/m (4.72 in.) outside the cylinder center lines, all parts of the valve motion can be located in the same plane. With the low-pressure cylinders such an arrangement is impossible, as the valves are driven by eccentrics which are placed on the first axle between the inside crank cheeks. The links, therefore, are mounted on rock shafts, which serve to transfer the motion from one plane to the other. These rock shafts are supported at three points, thus avoiding, as far as possible, any tendency to spring the valve motion. Independent reverse shafts are provided for the high and low-pressure valve gears, which may be operated together or separately by means of an ingeniously arranged screw reverse mechanism placed in the cab on the left-hand side.

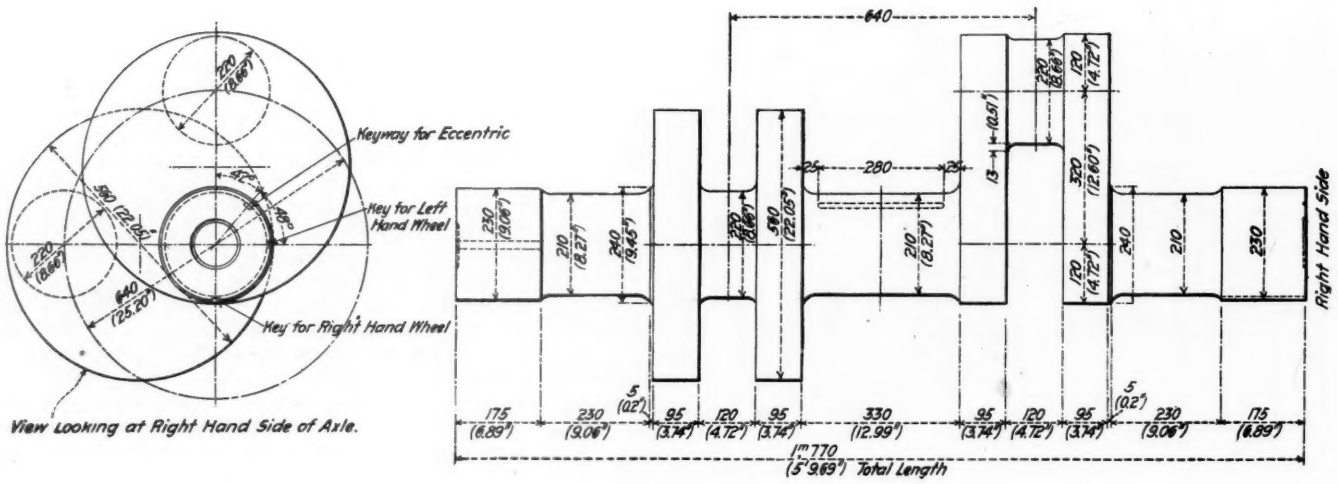
The driving wheel centers are of cast-steel with solid balances.



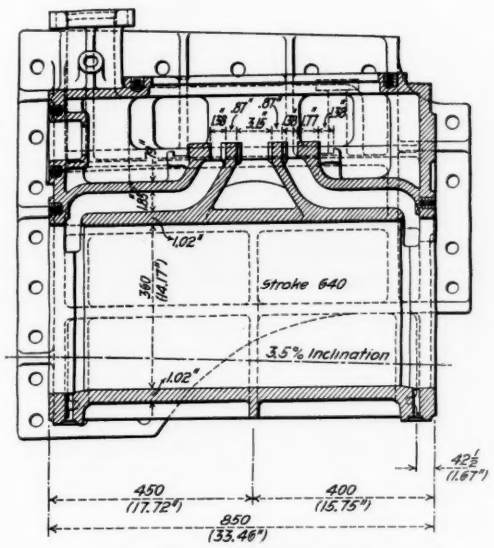




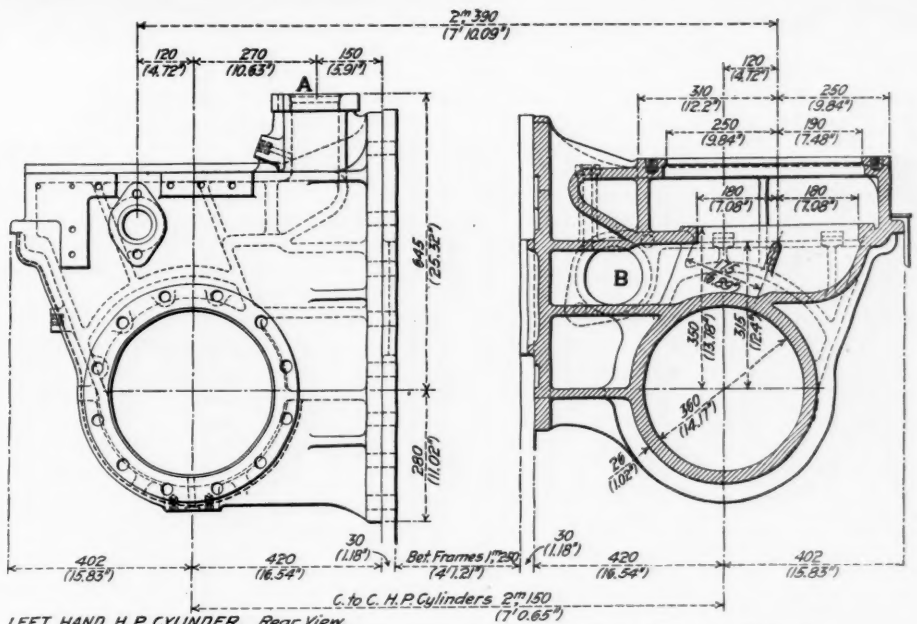
Low Pressure Cylinder; De Glehn Compound Locomotive.


Keyway for Eccentric
Key for Left Hand Wheel
Key for Right Hand Wheel
View Looking at Right Hand Side of Axle.
Right Hand Side
1m 770 (5' 9.69") Total Length

Crank Axle; De Glehn Compound Locomotive.

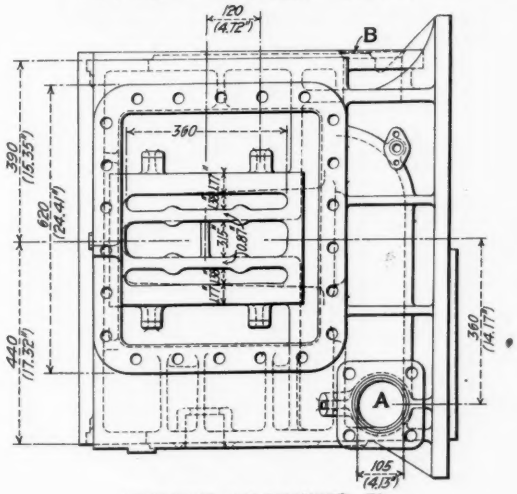


RIGHT HAND H.P. CYLINDER.
Longitudinal Section.



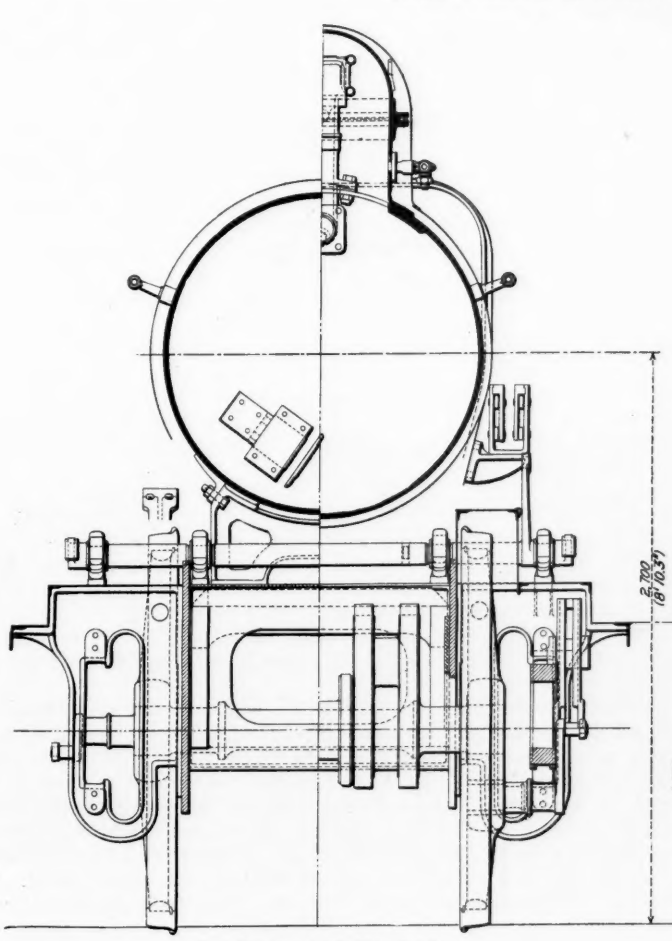
LEFT HAND H.P. CYLINDER. Rear View.

RIGHT HAND H.P. CYLINDER.
Section Through Exhaust.

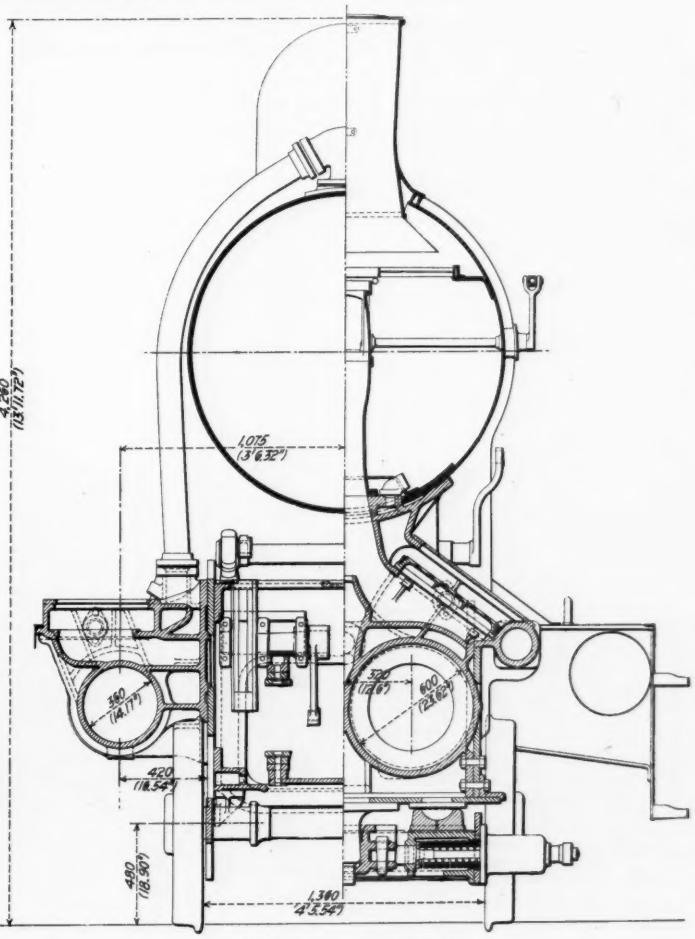


LEFT HAND H.P. CYLINDER. Plan.

High Pressure Cylinder; De Glehn Compound Locomotive.



Sections at Guide Yokes.



Sections at Cylinders.

The driving axles are of forged steel, the crank axle being forged in one piece. Wrought-iron driving boxes are employed, and the weight is transferred to the frames through underhung springs and forged steel equalizing beams. The engine truck side frames are of slab form, placed inside the wheels. The weight is transferred to the truck through two hemispherical bearings whose centers are 900 m/m (34.43 in.) apart, measured transversely. These bearings are seated in suitable castings which can slide on a heavy cast-steel crosstie. Lateral motion of the truck wheels is also provided, and is controlled by means of coiled springs. The center pivot supports no weight and is used simply for pushing the truck. The truck frame is suspended directly on the springs, no equalizing beams being used.

The boiler is of the Belpaire type, built of steel plate, with the exception of the inside firebox, which is of copper. The grate is placed between the frames and is inclined toward the front at a sharp angle, thus giving an exceptionally deep throat. The staybolts in the water legs are of manganese bronze. Each bolt is drilled throughout its entire length with a hole 6 m/m in diameter. These holes are closed up at their inner ends by riveting the bolts over after they have been screwed into the sheets. The firebox is provided with a brick arch which is supported on copper strips, secured to the side sheets by copper studds. The grate is of the rocking type. The tubes are soft steel, of the "Serve" pattern, with internal ribs.

The boiler shell is built with longitudinal butt joints having double covering strips, while the circumferential seams are double riveted with lap joints. The throat sheet completely encircles the barrel. The steam dome is built of flanged plate, with a full sized opening in the barrel, and the base is strengthened by an inside liner. In accordance with general European practice, the throttle valve is of the sliding type, and is fitted with a pilot valve which opens first. The pressure on the main valve is thus equalized, and it is more readily moved on its seat. The smokebox is provided with a high variable exhaust nozzle, above which is placed a horizontal grating composed of round rods set in a wrought-iron frame. The stack is of cast-iron with a covering plate for checking the draft. The locomotive is fitted with high-speed brake equipment furnished by the Westinghouse Air-Brake Company of London, and also with steam heating equipment. Screw couplings and spring buffers are provided at the front end of the locomotive and the rear end of the tender. The cab is built of steel plate, and has narrow side windows. Access to the running boards may be had by climbing around outside of the cab, and for this purpose suitable hand rails are provided. An interesting part of the equipment is the Hoesler Chronotachymetre, which keeps a complete record of the speed throughout the run, and also shows the enginemen the rate of speed at any instant. The motion for this device is derived from a stud which is screwed into the rear right-hand crank pin and works in a slotted arm on a gear shaft located under the running board.

The tender is carried on six wheels, the two rear pairs of which are equalized. The frames are of the plate form, placed outside the wheels. Both the engine and tender are provided with steps and handholds, and the gangways can be closed, on each side, by means of suitable gates.

The following are some of the principal dimensions of these engines:

	Metric.	English.
Gage	1.450	4 ft. 9 in.
Cylinder, h. p., diameter	.360	14.17 in.
Cylinder, l. p., diameter	.600	23.62 "
Piston stroke	.640	25.20 "
Boiler, type	Belpaire	
" material	Steel	
" diameter of shell	1.513	59.57 in.
" thickness of sheets	.0185	.73 "
Fuel	Coal.	
Steam pressure	16 kg. per cm.²	227 lbs.
Firebox, material	Copper.	
" length	3.043	9 ft. 11.8 in.
" width	1.000	3 " 3.37"
" depth front	2.100	6 " 10.68"
" depth back	1.470	4 " 9.87"
" thkness, side, bk, crwn.	.016	.63"
" thickness tube sheet	.030 & .016	1.18 in. & .63 in.
" water space, frnt & back	.095	3.74 in.
" sides	.074	2.91 "
Tubes, type	Serve ribbed.	
" material	Steel	
" number	139	
" diameter	0.070	2.76 in.
" length	4.455	14 ft. 7.39 in.
Heating surface, firebox	16.17 m.²	174.0 sq. ft.
" " tubes	223.23 m.²	2,402.0 "
" " total	239.40 m.²	2,576.0 "
Grate area	3.10 m.²	35.36 "
Wheels, diameter, driving	1.850	72.84 in.
Wheels, diameter, trucks	.960	37.8 "
Wheel base, driving	4.200	13 ft. 9.36 in.
" " total	8.250	27 " 0.8 "
" " engine and tender	14.860	48 " 8.04 "
Weight on driving wheels	Light.	110,000 lbs.
" " truck wheels.	Light.	42,900 "
" " total	Light.	152,900 "
" " engine and tender	Light.	195,000 "
Tank capacity, coal	20 cm.	705.8 cu. ft.
Tank capacity, water	6,000 kg.	1,580 gals.
Service	Passenger.	
Tractive effort		21,466 lbs.

$$\frac{\text{Weight on drivers}}{\text{Tractive effort}} = 5.12$$

$$\frac{\text{Total weight}}{\text{Tractive effort}} = 7.12$$

$$\frac{\text{Tractive effort x diameter of drivers}}{\text{Heating surface}} = 606.98$$

$$\frac{\text{Heating surface}}{\text{Grate area}} = 77.22$$

$$\frac{\text{Firebox heating surface}}{\text{Total heating surface}} = .0675$$

$$\frac{\text{Weight on drivers}}{\text{Heating surface}} = 42.7^*$$

$$\frac{\text{Total weight}}{\text{Heating surface}} = 59.35^*$$

Volume 2 h. p. cylinders ..... 4.6 cu. ft.

$$\frac{\text{Total heating surface}}{\text{Volume 2 h. p. cylinders}} = 560$$

$$\frac{\text{Grate area}}{\text{Volume 2 h. p. cylinders}} = 7.69$$

Equivalent of tube heating surface in firebox heating surface ..... 628.8 sq. ft.

Total equated firebox heating surface Vaughan's formula ..... 752.8 sq. ft.

Ratio of high to low-pressure cylinder ..... 1 to 2.78

*By English equivalent.

Gasolene Motor Cars for Railroad Service.*

We have, in pumping and coaling stations, stationary gasolene engines that are delivering power at a cost of $1.56 per horse-power hour for fuel; this as compared with $1.92 per horse-power hour for steam power. There is no logical reason why this very economical power cannot be utilized for operating a transportation medium on an isolated railroad line. Furthermore, the electric lines have demonstrated that large profits result from the economical operation of self-propelled cars. These electric lines, with their frequency of service and ability to handle a large number of passengers, when brought into competition, take all the steam railroad passenger business.

I do not believe steam power for motor-car service will ever be economical. Steam dummy service is and always has been inviting; yet, in the face of the many failures in the past, even under favorable conditions, there has not been sufficient advancement or improvement made in the utilization of the steam power of to-day to insure the success of the steam motor car.

The modern locomotive and steam motor car, with high steam pressure and the attendant flue and firebox troubles—the troubles due to formation of scale, broken staybolts, leaky front-ends, defective draft, poor coal and kindred necessary evils incident upon the use of a separate power-generating unit, such as a boiler entails —are much more complicated and vulnerable pieces of machinery than the gasolene motor car in which, technically speaking, there is nothing present but (1) vehicle, (2) "prime mover," and (3) transmission; the complicated generator with its attendant multitudinous parts likely to give trouble being absent here. It necessarily and logically follows, to a mechanical mind, that a gasolene motor car, properly constructed and built with the same skill and care as a locomotive, is a much less vulnerable machine than a locomotive, and will undoubtedly give more continuous service without failures.

There is a great demand for a low-cost-of-operation, self-propelled passenger car; there are several kinds of transportation service to which the gasolene motor cars are particularly well adapted, and to which they are almost a necessity; many steam passenger trains are being operated at a financial loss, yet the passenger service must be maintained.

To meet these demands it seems necessary, in the present advance of civilization, that gasolene motor cars be designed for use particularly on steam railroads.

Branch lines collect freight traffic and feed the main line, and the limited passenger business, of course, can be handled economically when turned over to the main line. Thus it is, if the steam train could be replaced by a combination motor car, a great saving could be made in the operating expenses. Passenger traffic which would be insufficient to fill a steam train in most cases would justify the operation of a gasolene motor car. Frequency of service could be given the public, which, of course, is much appreciated. The number of trips, cost of operation, etc., is entirely dependent upon

*From a paper read before the New York Railroad Club, April 19, by W. R. McKeen, Jr., Superintendent of Motive Power of the Union Pacific.

the density of traffic and the length of the branch line. Now, on steam railroads in direct competition with the frequent service of electric lines, a motor car of high power is necessary to obtain the rapid acceleration and high speed required for this class of service. However, with these high-power engines there seems to be no particular increase in the cost of operation, as larger engines work more economically per horse-power developed than the smaller one. These cars are an entirely new style of transportation medium, and should be built, not along the conventional lines of an electric car, a steam passenger coach or railroad locomotive, but should be designed on entirely new lines; in other words, on lines particularly adapted for this new class of service.

In designing the car body of the motor car, three points must be considered, viz.: weight, cost and strength. In evolving a design of motor car, I thought it absolutely essential to use steel only. A motor car operated in connection with steam train service will, at times, be subjected to severe shocks, and it has been my idea to design a car of steel that would stand any sort of a shock without danger of collapsing or telescoping. Instead of having an underframing of excessively heavy sills with a light cracker-box framing above, we have endeavored to make the whole car body a unit structure, heavy parts of which brace its adjacent members, and in case of a wreck every bit of steel in the car would be utilized in offering resistance to same. Thus, our underframing comprises but one moderately heavy center sill; the side sill is a light-weight continuous channel extending around the body of the car. From this outer channel bar we have continuous steel ribs running up the side through the roof and down the other side of the car; these are braced to each other by suitable cross-braces. The sides of the car form a truss; the plate of the car being the top chord and the sill being the bottom chord. This framing is well tied together at all points, and is further reinforced and strengthened by the sheet steel covering. The ends of the car are enormously strengthened by the round shape at the rear and the pointed lines in front. In a collision this car could be punctured or bent, but it could not be telescoped. One of these cars in an accident struck a switch locomotive while running at about thirty miles an hour. The car was struck in the rear and but slightly damaged; the steel plates were bent up; the ribs of the car were broken loose and badly bent, but the frame of the car was not in any way damaged, except just at point of contact with the locomotive. Beyond where the car was struck the paint was not even cracked, showing that even under this severe shock there had been no movement of the members of this steel frame except in unison with each other.

The latest design of car, with metal frame round windows, enables the diagonal braces of the steel frame to be brought very close to top of car, and by lowering the roof and bringing plate of car closer to the side sill we get an enormous increase in the strength of the car side, and the side of the car comes more nearly to the form of a girder.

AIR RESISTANCE.

(*From the Berlin-Zossen Test of* 1902.)

The test conducted with the car having 97 sq. ft. of flat end surface, the air resistance was as follows:

At 25 miles per hour, 2.5 lbs. per sq. ft.
At 50 miles per hour, 8.2 lbs. per sq. ft.
At 62 miles per hour, 12.6 lbs. per sq. ft.

No figures are given for wedge-shaped or parabolic front ends, but summing up these tests, the following statement is made: As the air resistance forms the greater part of the total resistance of rapidly moving trains, it is essential to design the outer form of the car so that the air resistance should be reduced as much as possible. According to the results of the tests described above, the best conditions would prevail if the front end of the car had the form of a very sharp parabolic wedge.

(*From the Report of the Electric Railway Test Commission, Louisiana Purchase Exposition,* 1904.)

In the car used with flat ends, the maximum speed obtained was fifty miles per hour; with parabolic ends, maximum speed was increased seventy-five miles an hour.

The head-on pressure for all speeds averaged about one-fourth for parabolic front what it did for a square front.

Unit pressure at eighty miles per hour was ten times that at twenty miles per hour.

At sixty miles per hour the unit pressure on a wedge-shaped front was 2.10 lbs. and on a flat vestibule 8.2 lbs.

On a flat vestibule unit pressure at twenty miles per hour was 1.4 lbs., at eighty miles per hour it was 14 lbs.

On a wedge-shaped end, .4 of a pound at twenty miles per hour, and 4 lbs. at eighty miles per hour.

The suction at the rear end on the standard vestibule was equivalent to 16 horse-power at sixty miles per hour.

TRANSMISSION.

The gasolene engine is unquestionably a successful, practical and economical power generator; the motor car body, trucks, etc., built of steel, have been perfected. The means for connecting the gasolene engine to a motor car is the main difficulty in utilizing the power of an internal combustion engine. A variable speed engine, adapted for controlling the car at various speeds, and a mechanical means for throwing in a gear for starting car, to be used in case of emergency on excessive grades, is so simple that it leaves no doubt as to the practicability of this form of construction. With the Union Pacific motor cars, after the car is once in motion, the propelling mechanism consists simply of an engine and a sprocket mounted on crankshaft, the power being transmitted therefrom through a chain, into a second sprocket keyed on the driving axle. There are no noisy gears, no complicated mechanism for absorption of the power; it is so simple that the economical and practical features of this transmission can be readily appreciated.

THE ENGINE.

It is generally conceded that a gasolene engine is a constant speed machine; that used as a power generator, any variation in speed must be secured by mechanical methods outside the gasolene engine. The gasolene engines used for stationary purposes are all regulated by a governor and maintained at a constant speed. In the automobile business it is particularly noticeable that foreigners, in building their machines, figure on controlling the speed of the automobile by a multiplicity of gear speeds, often as high as four or five gear speeds, thus by their design admitting that the gasolene engine should run at a certain fixed speed. American builders of automobiles frequently control their machines with only two gear speeds, although many of them use as high as four and five.

All motor car experiments up to date have been based on the constant speed of a gasolene engine.

One of the most attractive features of the steam automobile is the ease with which the speed of the machine is controlled. This is due to the flexibility in control of the steam engine. We see on the locomotive every day the flexibility of the steam engine utilized in starting passenger and freight trains from a condition of rest, accelerating same to a speed of seventy to eighty miles an hour. Now, for a motor car to operate on a steam railroad where the simplicity of the machine is almost imperative, and all the conditions such that an operator with a reasonable amount of experience may direct his mind to guiding the car from station to station, at the same time being able to keep his eye continually on the track—the gasolene engine and machinery for propelling the car must be flexible of control and of itself require very little attention; in other words, it must be analogous to a steam locomotive—able to stand hard service, hard work and abuse, and yet at the same time be sure, be reliable in its performance, and avoid stoppages between stations where same would cause undue complications in the operation of regular train service.

Union Pacific motor cars were originally designed and developed on the basis of controlling the speed of the car by varying the speed of the engine; accelerating the speed by opening the throttle, thus giving the engine more gasolene, this being analagous to opening the throttle on a locomotive; advancing or retarding the spark being analogous to varying, by the reverse lever, the valve motion and the lead of the valve on the locomotive.

Motor car No. 8 was equipped with 200 h.p. gasolene engine, designed and built at the Union Pacific shops, at Omaha. The engine was designed particularly for motor car service, and the hope for a flexible-control engine has been fully realized, the engine being able to start and accelerate car from zero to sixty miles an hour simply by varying the speed of the engine. If car attains speed of fifty miles an hour, and it is desired to run slower, the same can be accomplished by simply closing off the throttle, reducing the consumption of gasolene, and therefore saving fuel. Thus you control the horse-power developed in the engine by means of the gasolene supply, and the cost of fuel, then, must be in proportion to the power demanded from the engine. In my opinion this saving in a gasolene engine is proportionately greater than in a steam locomotive. This flexible control is obtained through the following: (1) Utilization of six cylinders, giving a power impulse to the shaft three times each revolution; (2) by balancing the crankshaft and reciprocating parts (the uniformity of speed is improved); (3) the gasolene vapor pipes from carburetor to cylinders are, by special design, all equally divided, and the distance the vapor travels is the same in each and every case; thus no one cylinder takes its charge of gasolene at the expense of another; (4) the dimensions of the cylinders, the opening and closing of the inlet and exhaust valves and the relative timing of these valves to each other, as well as to piston, have all been of particular importance; (5) (as before mentioned) the valve motion of a six-cylinder gasolene engine is analogous in many ways to the valve motion of a steam locomotive. We know perfectly well that a valve motion suitable for a high-speed passenger train is not economical, nor is it satisfactory for hauling heavy freight trains. The idea in the valve motion of the motor car gasolene engine is to operate the valves so as to produce as nearly as possible uniform horse-power by these cylinders at various speeds.

In moving the car through a series of switches in a busy yard,

with the necessity for letting the brakeman off to run ahead and throw switches, pick him up after passing through same, it is almost imperative that the operator be not bothered or interfered with by the necessity of throwing speed-changing devices, etc. With the Union Pacific variable speed engine the operation is very simple, throwing on or off the friction clutch being the only move necessary to vary the speed of the car. Even though the car reduces to a speed of two or three miles an hour by simply throwing in the clutch, the load will be assumed and taken care of by the engine without any bucking, such as is often experienced with automobiles and other constant-speed engines. The throwing on or off of the clutch is actuated by air, this air being controlled by an operating valve, the lever of which, being small and in the hands of the operator, it is easy for him to keep his head out of the window, watch the brakeman, the movements of the car, and handle the gasolene engine mechanism without any undue complications or without taking his eye off the track.

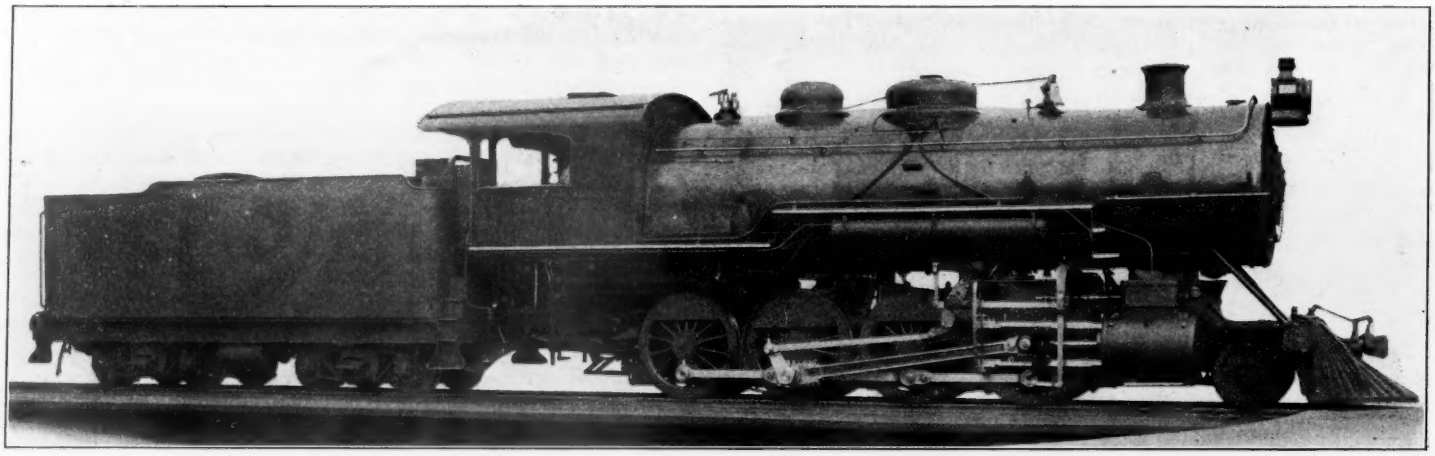
COST PER MILE FOR OPERATION OF MOTOR CARS.

This includes cleaning, running and shop repairs, fuel, lubricating oil, and wages of motorman and conductor. The expense of fuel, repairs, cleaning, etc., runs very uniformly, but with the expense per mile being so largely dependent upon the number of miles run per day, as well as on the wages paid the car crew, comparisons are very unsatisfactory. In actual service cars run, some months, as low as 10 and 11 cents a mile; whereas, cars in other localities will run as high as 16 and 18 cents a mile, and in one case, where a 100 h.p. motor car and trailer has replaced a steam locomotive and train (account of the limited mileage made per day), the cost of operation runs as high as 20 cents a mile. On branch lines the motor car should make not less than 100 miles a day. The service of the gasolene motor car is unquestionably different from that of either electric or steam cars. To man the gasolene car with a steam train crew is exceedingly expensive and inadvisable, and does not produce proper results; to man the gasolene motor car with an electric car crew would be equally as unsatisfactory. A well-paid mechanical man to have entire charge and run the motor car, with an assistant to collect tickets, is the best and most economical arrangement possible.

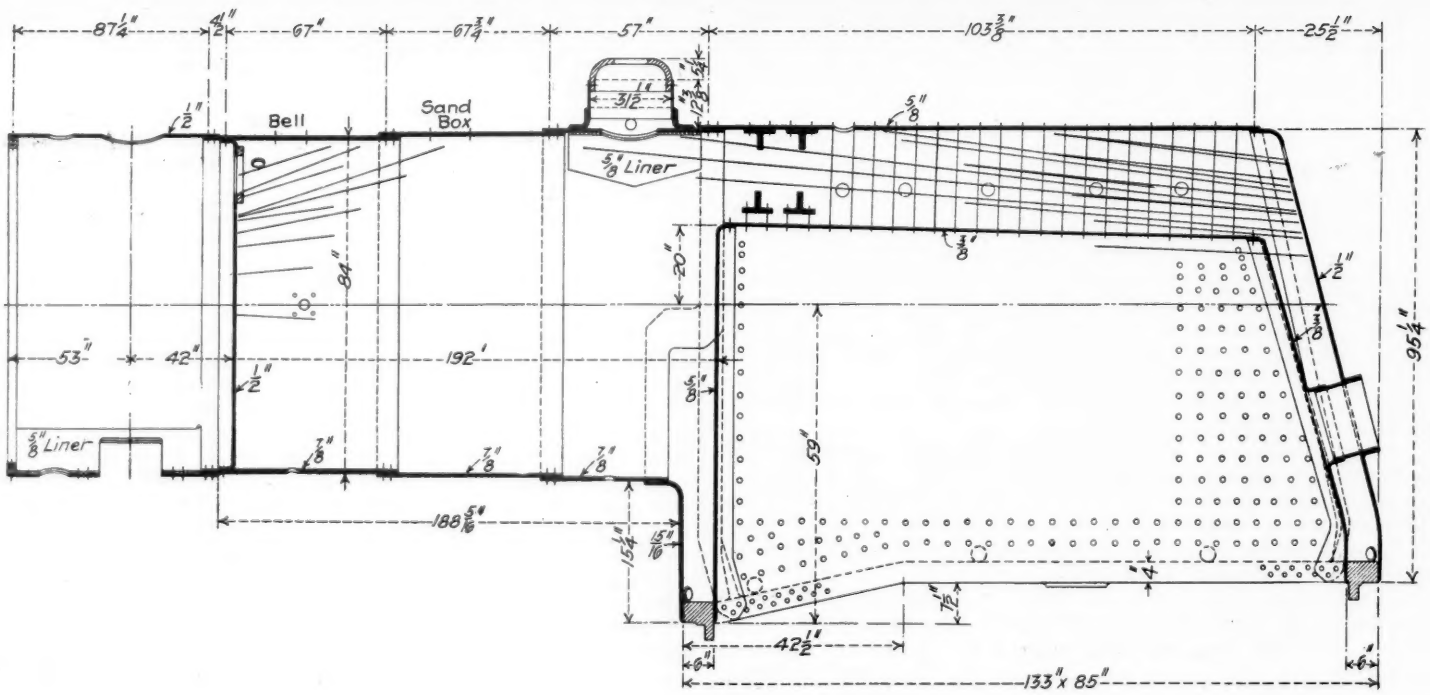
The Baldwin Superheater.

The Baldwin Locomotive Works is exhibiting at the Jamestown Exposition a consolidation locomotive equipped with a smokebox superheater. A distinctive feature of this device is that only the waste gases are utilized for superheating purposes, while the full heating surface of the boiler is retained. Hence no reduction in evaporative efficiency need be expected.

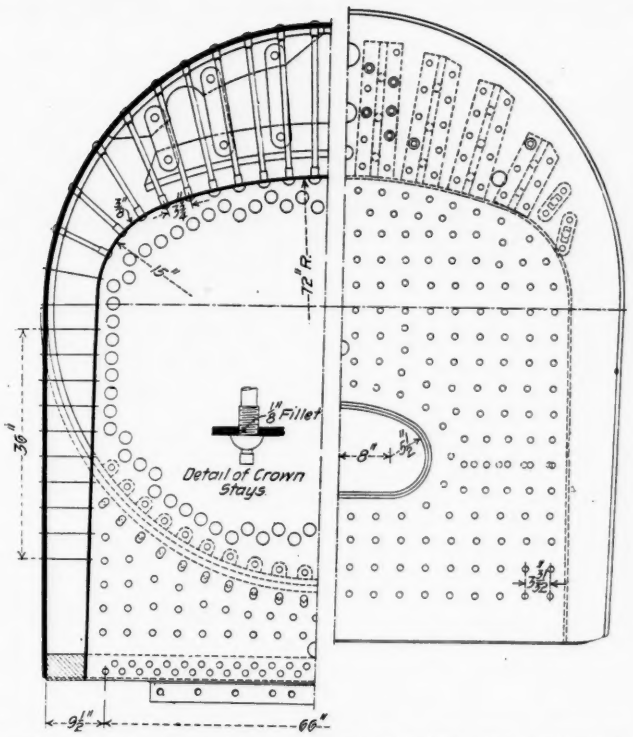
In the smokebox there is the usual tee to which is bolted a header or drum on each side that extends along the upper part of the smokebox to the front. This drum is divided by transverse and longitudinal partitions in such a way that the flow of steam is so controlled that it passes up and down from the upper to the lower drum and back as it moves to the front. This arrangement can be more readily understood by an examination of the plans of the two drums and the half section through the center of the boiler. In these it will be seen that the tubes are divided into five groups marked A, B, C, D and E respectively. The tubes forming these groups are expanded into flat plates that form one side of the drum and which are held in place by bolts as shown, so that removal for repairs is comparatively easy. The tee connection from the dry pipe leads directly into the space above the group A, and passing down through these tubes, crosses at the bottom to group B. It rises through these and then moves longitudinally to the top of group C; goes down C, crosses and rises through D, then moves ahead to E, down through which it passes to the space that appears like a jacket beneath the drum on the section through the stack and is led back to the steam pipe delivering to the cylinder. These



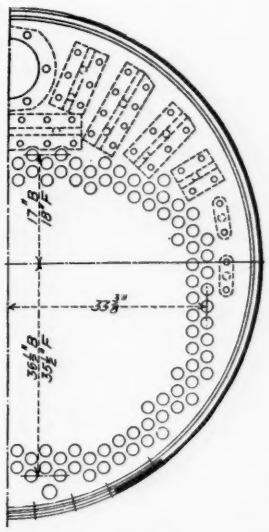
Consolidation Locomotive with Baldwin Superheater, at Jamestown Exposition.



Boiler for Baldwin Superheater.



Cross Section and Rear Elevation of Firebox for Boiler in Baldwin Superheater.

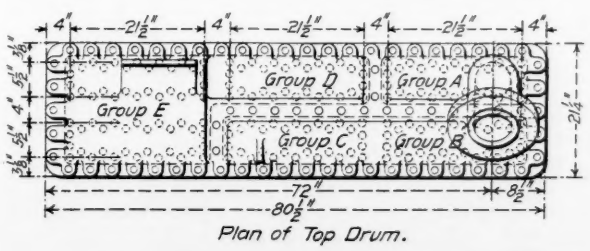


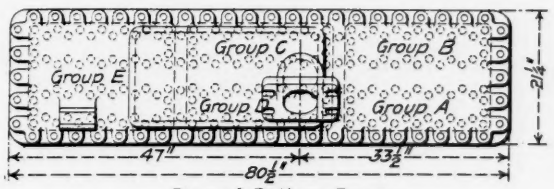
Half-Section of Front End Showing Tube Arrangement of Boiler with Baldwin Superheater.

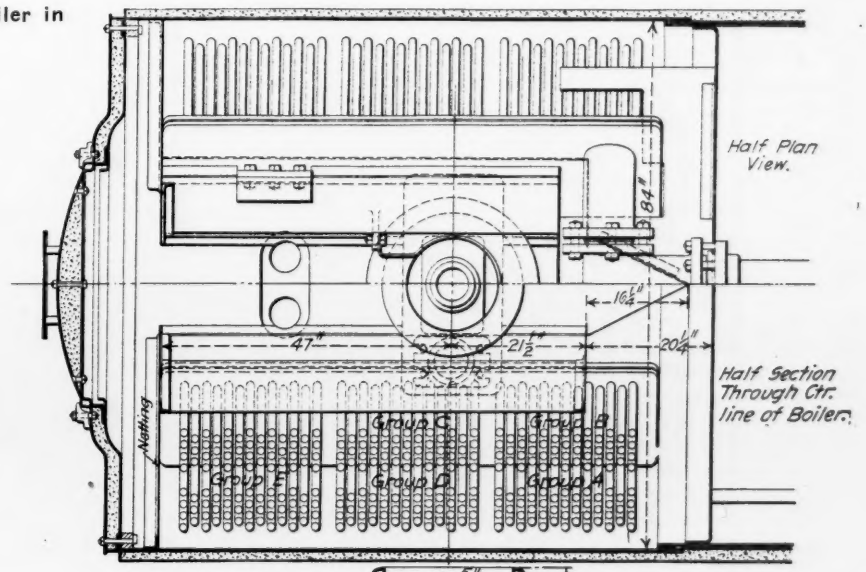
cross passages at the bottom and the longitudinal partition at the top are clearly shown in the section at the center of the stack.

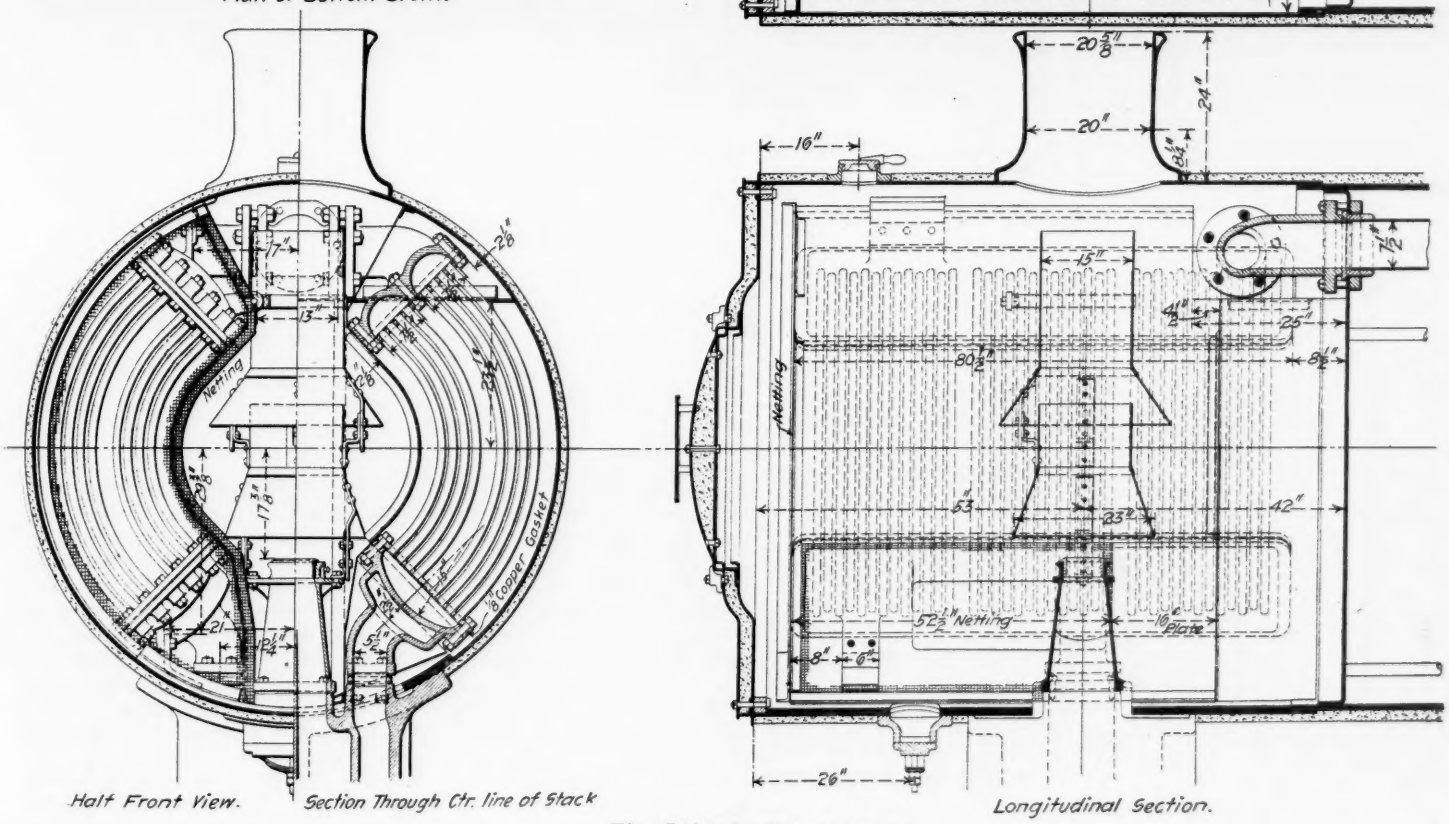
The course of the hot gases can be followed in the same way. As they emerge from the tubes they are separated at the center by a V-shaped partition by which they are diverted and made to pass forward on either side of the exhaust and petticoat pipes and through the nests of tubes to the front. Here they turn back and reach the stack opening by the middle passage that is clearly shown on the plan and vertical cross sections.

With this arrangement no part of the superheating apparatus is subjected to a higher temperature than that naturally belonging to smokebox gases that have passed through the tubes in the regular way, so that no provision is needed for checking or diverting the draft from the superheater tubes when the engine is shut off and no steam is passing through them. In the case of the boiler for this locomotive the shell has an outside diameter of 84 in. at the smallest ring and contains 474 tubes 2 in. in diameter and 16 ft. long. The firebox has inside dimensions of 121 x 73 in., so that there is a large









The Baldwin Superheater.

grate, but not one upon which an excessive amount of fuel could be burned, consequently the smokebox temperatures will probably be no higher than those ordinarily obtaining in regular practice.

These temperatures are, however, here preserved as far as practicable for superheating purposes by jacketing not only the shell but the front of the smokebox.

In the most recent development of this form of superheater, steam is passed first through the forward group of tubes, so that it circulates through the hottest part of the device immediately before reaching the cylinders.

The application has not yet been made for a sufficient length of time to make it possible to draw definite conclusions from the results that have been obtained; a matter that will be taken up later.

Changing the Gage on the Louisville & Nashville.

BY REUBEN WELLS.

(The complications and delays to traffic which were occasioned by the diversity of railroad gages in use in this country 20 years ago, and the long battle which the *Railroad Gazette* fought for the adoption of the standard 4 ft. 8½ in. gage, are well known to the older readers of the paper. For the interest of the younger railroad force, and for the historical record thus presented, we asked Mr. Wells to describe the changing of gage on the Louisville & Nashville from 5-ft. gage to standard, which was done in 1886. Mr. Wells was second assistant to the president at that time, and to him was assigned the duty of preparing plans and issuing instructions for carrying out the work.—Editor.)

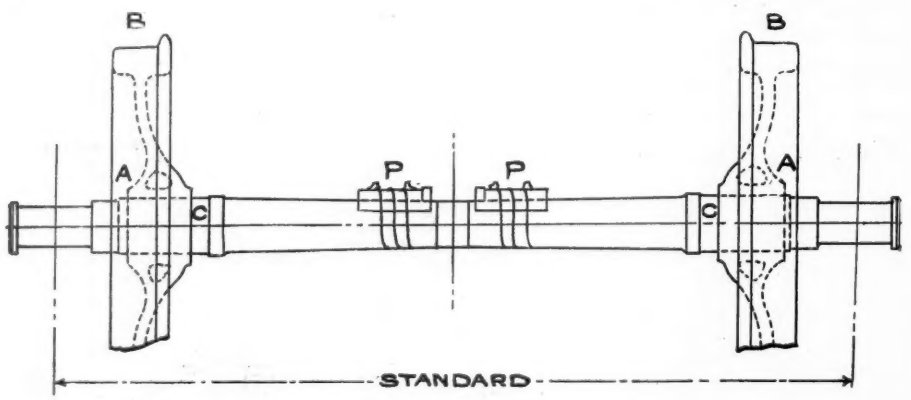


Fig 1.

On taking charge of the mechanical department of the Louisville & Nashville lines in 1878, it was decided that in adopting standards for new rolling stock that should afterward be put on the line, provision should be made for a change of gage, then foreseen as likely to occur some time in the future, consequently all new equipment, renewals of old, such as axles, boxes and trucks, was made the same as the M. C. B. standards, used on standard gage roads. To do this, however, all car and tender wheels were made with 1 in. more "dish" on "the outside" (at A, Fig. 1) than usual for standard gage wheels, to give sufficient room for the standard oil box when the tread of the wheel (at "B") was 5 ft. gage. All new car and tender axles were made M. C. B. standard, and turned to the diameter of the wheel fit, inward at "C" 1¾ in. farther than necessary for the wheel when at 5 ft. gage, so that in changing to standard the wheel had only to be pressed inward on "C" that distance.

In the case of new locomotives, their driving wheel centers and those for renewals were made with a wider face than the standard width of tires, the extra width being on the inside, as at "D," Fig. 2.

To change such engines to standard gage, it was only necessary to raise the wheels off the rail 3 or 4 in., heat the tires by enclosing them in a sheet iron, circular shaped box, about as shown in section at "E," Fig. 2, using wood for fuel, or oil, in a hoop shaped pipe, about as shown at "F" (both plans were used), the same as commonly used now for removing tires, without taking the wheels from under the engine.

For wood fuel an opening at the top of the box "E" produced the required draft. In using an oil pipe "F," small holes on its inner side "sprayed" the oil on to the face of the tire.

When expanded so as to become loose on the center, the tire was then driven inward to "K" against the four gage clamps at "G," previously set and bolted to the wheel, which made the gage right and tire true on the center. In the case of engines with wheel centers of the usual width, and at 5 ft. gage, tires of an extra width, as at "H," Fig. 3, at change of gage, previously provided, bored to suit the wheel centers, were on hand ready to be applied.

In such cases after removing the old tire, the new wide tires was put on, as shown at "I," the inner face at standard gage projecting over the wheel center at "L" about 1½ in. Tires of that section, put on previous to the change of gage (as many had been in making renewals), were placed on the centers as at "J-J." In changing gage they were then simply moved in to "I" (standard), remaining so until worn out. Such tires put on at 5 ft. gage gave no trouble whatever in service either before changing or after.

The width of the main frames of the engines over all was small enough to admit of the tires being set in to standard gage, as at "I," and the connecting rods were far enough out to allow of the tires being at 5 ft. gage (as at "J-J") without interference, consequently, no change of engine frames, wheel centers, axles, crank pins, etc., was necessary. Brake hangers, heads and beams, of course, required changing to suit the gage.

At change of gage, new standard gage engine truck wheels and axles were in most cases previously provided for each engine, and on hand for replacing the originals. Some truck wheels, however, had a separate collar between their hub and the box. In changing gage these collars were removed by splitting, and the wheels then pressed in on the axle to standard gage. No change in the width of the truck frames or truck boxes was necessary. Each individual locomotive was previously carefully examined, and all the supplies needed for changing it were on hand at the time, ready to be applied.

The above explains mainly the preparatory work that had been done from time to time in arranging the rolling stock, so that its change of gage could be made within as short a time and at as small expense as practicable, when the time should arrive for changing.

Four months previous to changing gage notice was given that the change of the whole line would be made on Sunday, May 30, 1886, and that everything must be ready in men and material to accomplish the work during the 24 hours of that day. Printed instructions were issued to every division, branch and section of the line, how the work was to be carried on. One rail only was to be changed.

There was 1,574.6 miles of main line, single track, and 187.3 miles of side track on the 11 divisions, and 328.1 miles of branch line track and sidings, a total of 2,090 miles of track to be changed. The 11 short branches (328.1 miles) were changed the day before the main line, leaving, 1,761.9 miles to be changed May 30.

During the three months previous the face of the ties for 6 in. inside of the rail to be moved had been "adzed" off level by the regular gang of section men as they found time to do it, and spikes were driven partly down, as at "M," Fig. 4, 3½ in. from the flange of the rail, a suitable gage being used between rail and spike, at "N" in driving, to insure correctness in the alinement, so that in changing, after drawing the old spikes on the inside, and moving the rail to the spikes at "M,'" then driving new spikes on the outside, previously distributed at "O" for the purpose, and driving home the spikes at "M," the rail would then be secure and the track standard gage.

Switch tie-rods of lengths to make the rails standard gage, and also standard gage crossing frogs, were previously distributed to all places where required for changing.

The "sections" of track in charge of one gang of six or seven

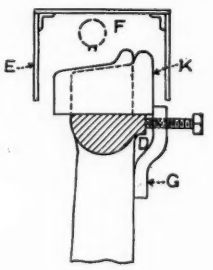


Fig. 2.

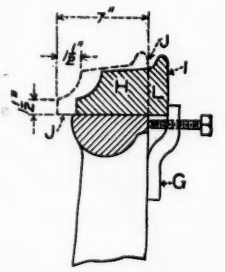


Fig. 3.

repair men averaged about four miles. Previous to changing each section was furnished with all the tools and appliances necessary for two gangs of men changing track, and the additional number of men to give four men to the mile were arranged for, to assemble at 4 o'clock a.m. on the day of change at the middle of the section, with a day's provisions with them. The regular section gang was then divided in two, and the full quota of men required for each was made up from the additional men employed for the day. The instructions were that the two gangs should start changing at the middle of the section at the hour mentioned, and work from each other, and continue until they met the gang working towards them from the adjoining section regardless of section terminals, so as to avoid a gap of unchanged track that otherwise might be left for a time. When the gangs changing met, each was then to go back over the track they had changed to the point of beginning,

correcting anything that might at first have been overlooked.

For changing the 1,761.9 miles of main line, over 7,000 men were required for the day. In the operation changing the rail, three men passed along drawing the inside spikes, two followed with lining bars moving the rail inward against the spikes previously driven at "M," Fig. 4; these were followed by the three or four men driving the spikes, as explained.

For storing and changing the rolling stock 13 different shops and points at terminals were selected. Extra wheel presses were located there where necessary. Some were stationed on platform cars with a portable engine and boiler. These were taken to convenient points in yards where cars were to be stored, the trucks removed and body placed on the ground for convenience in getting the wheels to and from the press.

Careful estimates were previously made as to the number of cars and locomotives that would be assembled at each place for changing at the hour when the lines and branches would be cleared of rolling stock. A sufficient amount of trackage in the yards at each place was selected for holding the rolling stock that would be assembled there (in all 45 miles was required). During the previous day one rail of these storage tracks was moved inward to 4 ft. 11 in. gage. In storing the rolling stock it was run in on these compromise tracks.

After changing the wheels to standard and putting them under again, the cars (or engines) could be hauled off from these tracks without the wheels dropping between the rails. This arrangement made it unnecessary to lay more than a total of two and a half miles of track in changing gage. In removing the wheels from cars "hooks" or short jacks were used between the ground and the truck bolster for raising the car body and truck together 3 or 4 in. so as to take the weight from the journals and boxes and allow the box bolts to be removed, wheels run back, as at "R," Fig. 5, swing around, then run out and rolled to the press to be changed. In most cases wheels that had been changed were put in their place at once. As all axles, boxes and bearings were interchangeable, wheels when changed were put under cars indiscriminately that happened to be most convenient.

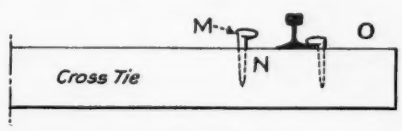


Fig. 4.

The journal bearings, however, were wired to the middle of the axle, as shown at "P-P," Fig. 1, and followed it, so as to be put back on their respective journals again, regardless of the truck the wheels were afterward put under. This served to avoid trouble from hot journals after going in service again.

For changing the passenger equipment in daily service on the line, new wheels and axles, previously provided, were at the terminals where the change was to be made. These cars were run in on tracks of 4 ft. 11 in. gage, jacked up and had their wheels replaced by those of standard gage during the day of change, and were ready to go in service again that evening. The wheels removed were pressed to standard gage and used under freight or other cars the same day.

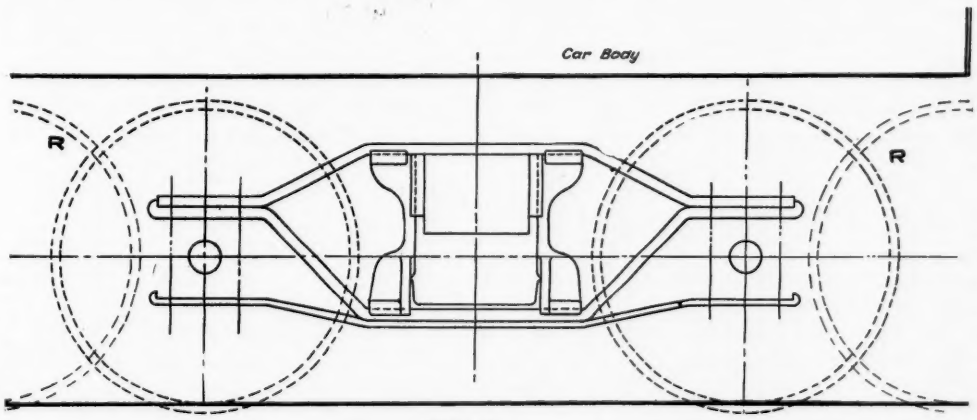


Fig. 5.

At both Louisville and Henderson, Ky., where the standard gage roads north connected, power car hoists for raising car bodies for exchanging their trucks for others of the gage of the road over which the car was to go from there, carrying certain classes of freight, and for through sleepers, mail and express cars had been used for years. These hoists at the change of gage were a help. At the proper time, orders were issued on all divisions and branches that all cars and locomotives must be assembled at the terminals specified, before midnight of May 29, 1886. This order was carried out to the letter, and not a car or locomotive was left away from the storage point designated. Passenger trains were run on schedule time as near as practicable up to midnight, and then laid up for change at the terminals specified, had their gage changed next day (May 30), and were ready to resume their run in less than 24 hours after the time they were laid up.

It was arranged to have an engine with track inspectors start from each terminal of a division as soon as the track there was changed to make a careful inspection of the track and report by wire to headquarters at what time trains could resume their runs again. This was done in every case. The different branches mentioned a total of 328.1 miles were changed May 29th, and all complete by 6 o'clock p.m. of that day (in 14 hours). This was done in order to get the services of the men the next day for changing the main line. Of the 1,761.9 miles of main line and side tracks, eight of the divisions (1,072.3 miles) were finished changing in 15 hours and 30 minutes from the time of beginning. Of the other four divisions, one of 275 miles was 28 hours in changing, delayed five hours by a violent rain storm. One division of 87.6 miles was 29 hours in changing, not having a full quota of men, and having to change the tracks in two terminal yards. One division of 163.3 miles was changed just within the 24 hours allowed, and another division of 163.6 miles (in Florida) was a few hours over the 24, on account of the lack of a sufficient number of men. All divisions and branches, however, were changed in time for all trains of any importance to resume their schedules on the night of the day of change (30th) and morning of the 31st. No accidents occurred, nothing off the track, and everything went on as scheduled.

ROLLING STOCK.

There were 278 locomotives and 8,665 cars to be changed at the 11 different terminals. Previous to the day of change of track (May 30th) about 24 per cent. of the locomotives, 30 per cent. of the freight cars, and 17 per cent. of the passenger equipment had been changed, mostly those in shops for general repairs, and others that could be spared from service. Up to May 31, 3,437 freight cars had been changed, and by June 12 7,166, and by the 19th all were changed to standard gage. The day before the track was changed 38 cars of the passenger equipment were changed, on the 30th 92 were changed, on June 1 30, and by June 19 the entire car equipment was changed, just 30 days from beginning to change.

The change of gage of the 278 locomotives was made as follows: Number of shop engines and others that could be spared, changed up to May 30, was 122; changed on 30th, 93; changed from 30th to June 8, 31. The remainder (32) were put in the shops for change and repairs, and all were changed by June 30. Both the locomotive and car equipment was all changed within 30 days from the time of beginning the work of changing them.

Twenty-eight new standard gage locomotives, previously received and tested, were put on the line the day after the track was changed.

Cost of Changing Gage.

Changing 2,090 miles of track	$107,355.84
" 278 locomotives	57,281.90
" 8,665 cars	50,319.60
Total	$214,957.34
Average cost, per mile of track	$51.36
Average cost per locomotive	206.05
Average cost per car	5.80

"Change of gage" was charged with just what properly belonged to it. For instance, if at changing a locomotive its tires were found to be worn out, the cost of the new tires applied was charged to repairs, as in that case the engine required new tires whether the gage was changed or not, so in the case of worn out car wheels and axles. Where wheels were cracked in pressing to gage the cost of replacing them was charged to change of gage. Also, the cost of the extra tools supplied for changing the track and rolling stock was charged to change of gage. The change of the rolling stock was made entirely by the force of men regularly employed in the shops and yards at terminals, except on the day of change extra labor for car on wheel press work was employed for that day. The comparatively low cost of changing the rolling stock was due to the preparation made for it during the previous years, as mentioned. There was practically no interference with the regular every day traffic of the line, as it was closed to trains for only 24 hours, and that, too, on a Sunday. By Monday morning all trains had resumed their schedule time again. Between Saturday afternoon and Monday morning the 2,090 miles of 5 ft. gage track had been changed to standard gage, and traffic moving as usual, but on a new gage, and as quietly and safely as on the original. By good management and doubling some of the engine service for about two days no lack of cars or of motive power was experienced, either before or after the day of change.

M. Noblemaire, since 1881 General Manager of the Paris, Lyons & Mediterranean Railroad, the greatest of the French systems, and

for 38 years in the service of that company, retired April 1, and was succeeded by M. Mawris, heretofore Assistant Manager and Chief Engineer. M. Noblemaire was decorated with the grand cross of the Legion of Honor on his retirement.

Pacific Locomotive for the Atlanta & West Point.

The American Locomotive Co. has recently built two Pacific (4-6-2) locomotives for the Atlanta & West Point at the Rogers Works. While possessing no unusual features of construction, they are excellent examples of a modern heavy passenger engine. In working order they have a total weight of 212,000 lbs., of which 130,000 lbs., or 61.3 per cent., is carried on the driving wheels.

The cylinders are 22 in. diameter by 28 in. stroke, and are equipped with slide valves actuated by the Stephenson link motion. With 72-in. driving-wheels and a boiler pressure of 200 lbs., these engines will develop a maximum tractive power of 32,000 lbs.

The boiler is the straight top design and is made in three courses, the outside diameter of the first and smallest course being 72½ in. It is fitted with 278 tubes of 2¼ in. diameter and 20 ft. long, and has a total heating surface of 3,532 sq. ft. This gives a ratio of heating surface to the total volume of the cylinders of 287, a figure which would indicate a large boiler capacity for sustained high speed.

The firebox has a width of 73¼ in. and is 107½ in. long at the mud-ring, and has a grate area of 55 sq. ft., or 1 sq. ft. of grate area for every 64.2 sq. ft. of heating surface. With this proportion between grate area and heating surface there should be no difficulty, with an average grade of bituminous coal, in generating plenty of steam without forcing the fire to an uneconomical rate of combustion.

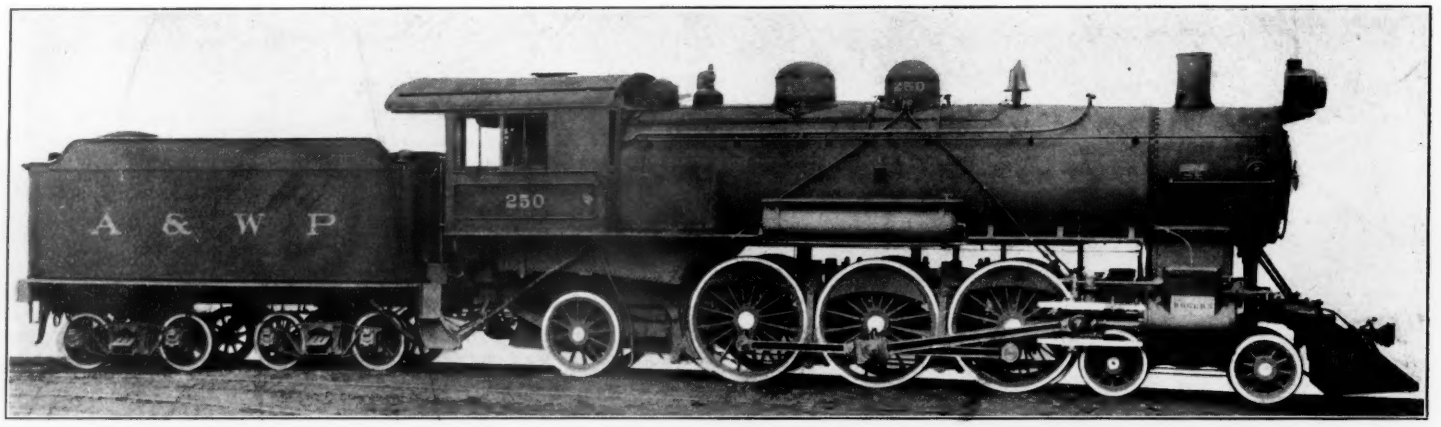
There are one or two features, also, in connection with the boiler to which attention should be called. One, which will be at once noticed in the reproduction of the photograph, is the location of the injector check on top of the front course of the shell and about 30 in. back of the forward tubesheet. This is simply another variation in the position of the injector check that will be a novelty to some and which merely emphasizes the fact that there is no uniformity in practice regarding the placing of this important article on American locomotives. We find it set all the way from the back head to close to the front tubesheet. It is emphatically claimed that the location of the injector check has a very important bearing on the liability to tube leakage and quite convincing figures have been published in proof of the claim and yet there is no sort of agreement among the doctors. Years ago there was no question on the subject. In the days of the pump the boiler check was invariably set near the front end of the shell, but since the quantity of water to be evaporated has increased to its present volume the location of the check is being discussed, but usually from a purely academic standpoint. It certainly seems that there should be some best place, and if it is on the back head or the top of the shell there should be some means of proving it, and the gathering of this proof would probably be well worth while.

The general construction of the boiler is shown by the engravings of the firebox sections. The horizontal and circumferential seams have the usual sextuple and double rivetting, and at the dome the shell is stiffened by a liner 75½ in. long, 66 in. wide and ⅝ in. thick. This one feature emphasizes very strongly the difference between the old and the new. In the seventies when 125 lbs. per sq. in. was a maximum steam pressure, and the shell was ⅜ in. thick, the dome alone was quite sufficient to stiffen the opening that was made and little or no trouble, beyond an occasional leak, was experienced. In this boiler, however, with a shell thickness of ¾ in., where a pressure of 200 lbs. is carried, not only is the opening stiffened by a heavy dome base 1⅛ in. thick, but the liner above referred to is also considered essential. The high boiler and low dome also necessitates a special safety valve dome which is a hollow pear-shaped steel casting.

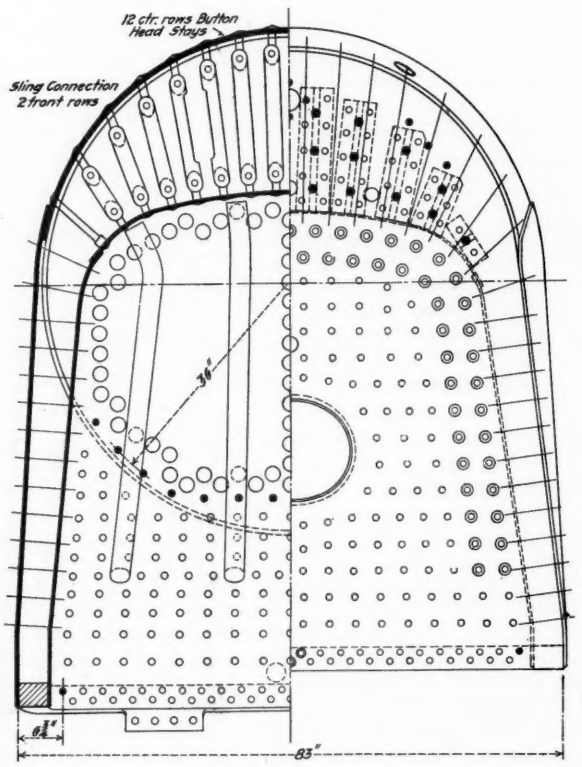
The firebox is fitted with a brick arch carried on circulating pipes, and the tubesheet is sloped forward to form a combustion chamber, although, of course, every boiler fitted with a brick arch has a combustion chamber in the space above it. Tate flexible staybolts are used along the front and top of the side sheets with plain bolts for the balance of the area. These are clearly indicated by the marking on the engraving. Attention is called to these matters as they are all indicative of current practice.

Finally the boiler emphasizes modern tendencies in the length of the tubes, which is 20 ft. This is not a novelty but is still enough of a rarity to attract attention when it is used. If Mr. Vaughan's formula for equivalent heating surface holds, the use of a 20 ft. tube as compared with one of 16 ft. gives an increase of but about 12 per cent. in equivalent heating surface in return for the 25 per cent. increase in the length of the tube. But 12 per cent. is a great gain in steaming capacity for a locomotive called upon for heavy passenger service, and this is but another item in the construction, already alluded to, that should make the steam supply on this engine ample without forcing, which further appears in the high equated firebox heating surface given in the schedule of dimensions.

Other minor details consist in the means of fastening the reverse lever bracket beneath the foundation ring, and the use of the electric headlight. At the rear, the tender is fitted with a Pullman vestibule, though it does not show in the photograph. This use of the vestibule on the tender, though old now was once new,



Pacific Locomotive Built for the Atlanta & West Point by the American Locomotive Company.



Half Rear Elevation and Section of Firebox of Boiler for Pacific Locomotive; Atlanta & West Point.

and before it reached a tentative realization was regarded as beyond the dreams of a possibility by even progressive railroad men. To illustrate this; when the vestibule was first applied to passenger cars, the late J. N. Lauder, Superintendent of Motive Power of the Old Colony Railroad, was an enthusiastic advocate of it on the grounds of safety. Speaking of it at one time, he said: "Its one of the greatest advances that has been made in passenger car construction in 25 years, and if I could have my way I'd put it on everything; yes sir, I'd put it on the rear of every passenger tender on the road." And now it is taken as a matter of common practice.

The main frames of the engine are 4½ in. wide while the section under the firebox, which is of cast-steel and spliced to the main frame, is 2 in. wide. Although the Stephenson valve gear is used, it has been found to be possible to brace the main frame with crossties at four points beneath the shell to which as many buckle plates for the support of the boiler are attached. The trailing truck is of the radial type with inside bearings.

The following are some of the principal dimensions of these engines:

Cylinder, diameter	22 in.
Piston stroke	28 "
Wheels, diameter, driving	72 "
" " trailing	50 "
" " front truck	36 "
Wheel base, driving	12 ft. 8 "
" " engine	32 " 5½ "
" " engine and tender	60 " 0 "
Boiler, type	Straight top
" diameter	72½ in.
" thickness shell sheets	¾ "
Firebox, length at top	127/32 "
" length at bottom	107½ "
" width at mud ring	73¼ "
" thickness side and back sheets	⅜ "
" " crown sheet	7/16 "
" " tube sheet	⅝ "
" water spaces	4½ "
Tubes, number	278
" diameter	2¼ in.
" length	20 ft.
Heating surface, tubes	3,261 sq. ft.
" " firebox	238 "
" " arch tubes	33 "
" " total	3,532 "
Grate area	55 "
Steam pressure	200 lbs.
Weight on front truck	46,000 "
" " drivers	130,000 "
" " trailing wheels	36,000 "
" total engine	212,000 "
" tender	133,000 "
Journals, driving	9½ in. x 12 in.
" truck	6 " x 12 "
" trailing	8 " x 14 "
" tender	5½ " x 10 "
Valves, type	Slide
" admission	Outside
" travel	6 in.
" steam lap	1 "
" lead in full gear	1/16 "
Tank capacity, water	7,000 gals
Tank capacity, coal	12 tons
Tractive power	32,000 lbs.

$$\frac{\text{Weight on drivers}}{\text{Tractive power}} = 4.06$$

$$\frac{\text{Total weight}}{\text{Tractive power}} = 6.63$$

$$\frac{\text{Weight on drivers}}{\text{Total weight}} = .613$$

$$\frac{\text{Tractive power x diameter drivers}}{\text{Heating surface}} = 652.32$$

$$\frac{\text{Heating surface}}{\text{Grate area}} = 64.2$$

$$\frac{\text{Firebox heating surface}}{\text{Total heating surface}} = 6.75$$

$$\frac{\text{Weight on drivers}}{\text{Total heating surface}} = 36.9$$

$$\frac{\text{Total weight}}{\text{Total heating surface}} = 60$$

Volume of cylinders.....12.32 cu. ft.

$$\frac{\text{Total heating surface}}{\text{Volume of cylinders}} = 287$$

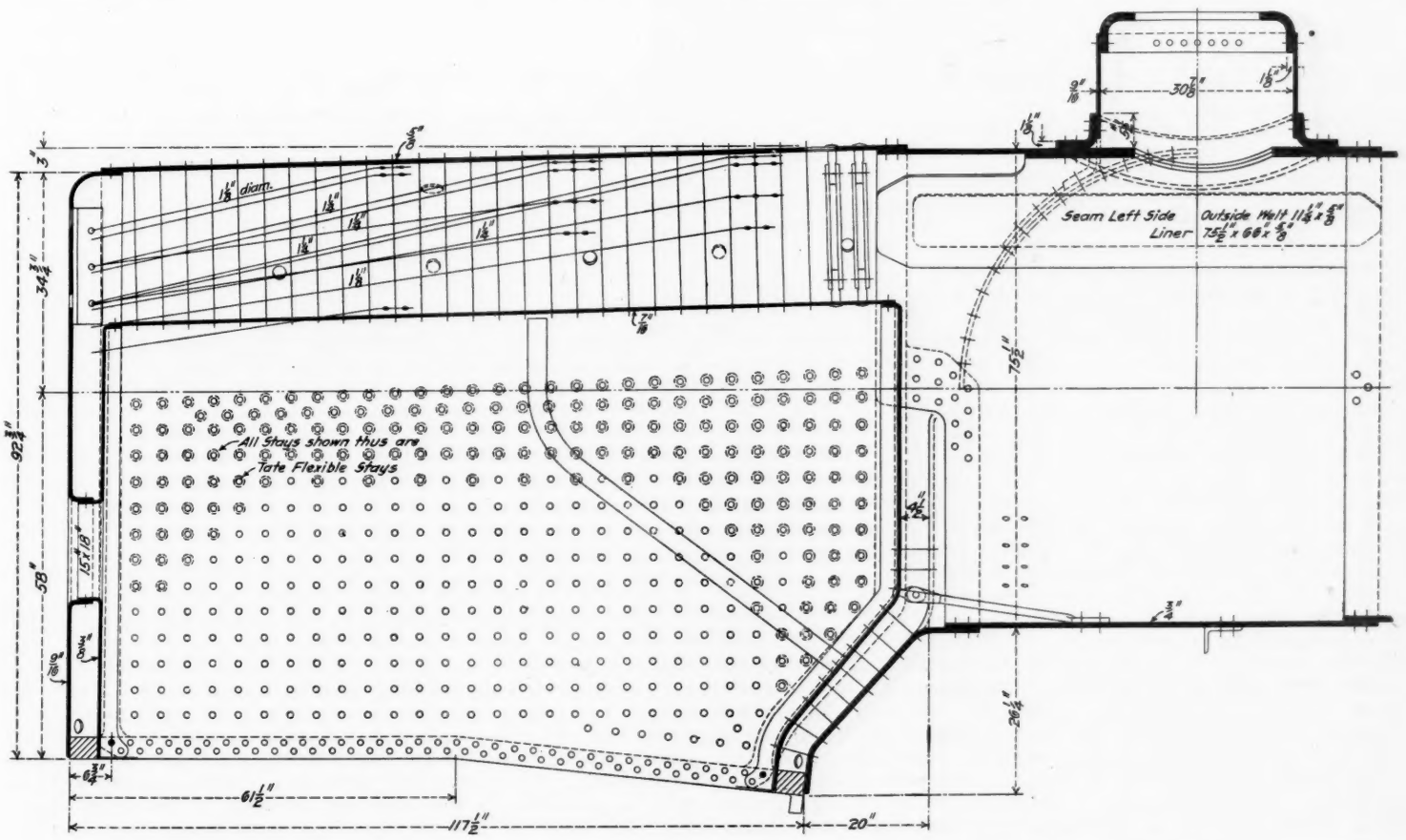
$$\frac{\text{Grate area}}{\text{Volume of cylinders}} = 4.46$$

Tube heating surface equated to firebox heating surface (Vaughan's formula)	729.8 sq. ft.
Total equated firebox heating surface	1,000.8 "

While these engines have been in service but a short time, the officials of the road report that their performance up to date has been entirely satisfactory and that they have exceptionally good riding qualities.

Thirteen Centuries of Service.

A dinner was given to the operating officers of the Chicago & North-Western by Vice-President Gardner several weeks ago at which there were some 56 men present from the President down to the chief train despatchers. There was represented in the party 1,300 years of service in the aggregate. The Chicago & North-Western does not think any other railroad, at least in the West, could make as good a showing.



Longitudinal Section of Firebox and Boiler for Pacific Locomotive for the Atlanta & West Point.

Proposed Long Rifled Pipe Line for California Oil.

The rifled pipe process for pumping California crude oil adopted by the Southern Pacific was described and illustrated in the *Railroad Gazette* of June 8, 1906. The oil from some of the California fields is a very heavy, thick and viscous fluid with an asphalt base. This is particularly true of the product of the Kern river fields, near Bakersfield, with which ordinary pipe-line methods are of no avail. As a result of systematic experimental study of the problem the process above referred to was finally worked out. This process, in brief, is the lubrication of the oil core within the pipe by a film of water enveloping it. A small percentage of water is injected with the oil and the effect of the rifling is to throw the water to the outside, forming the film mentioned and greatly reducing the friction. The practical details included the rifling of the pipe and involved the designing of a machine to accomplish same, the operation being done cold. A line was then built for commercial transportation of the oil. It lies between Volcan, which is on the Southern Pacific and is a central point in the oil fields, and Delano, 31 miles north on this same road. This line has proved so successful that it has been decided to extend it to San Francisco bay. The contract for the station equipment for this extension has just been let to the George E. Dow Pumping Engine Company, of San Francisco.

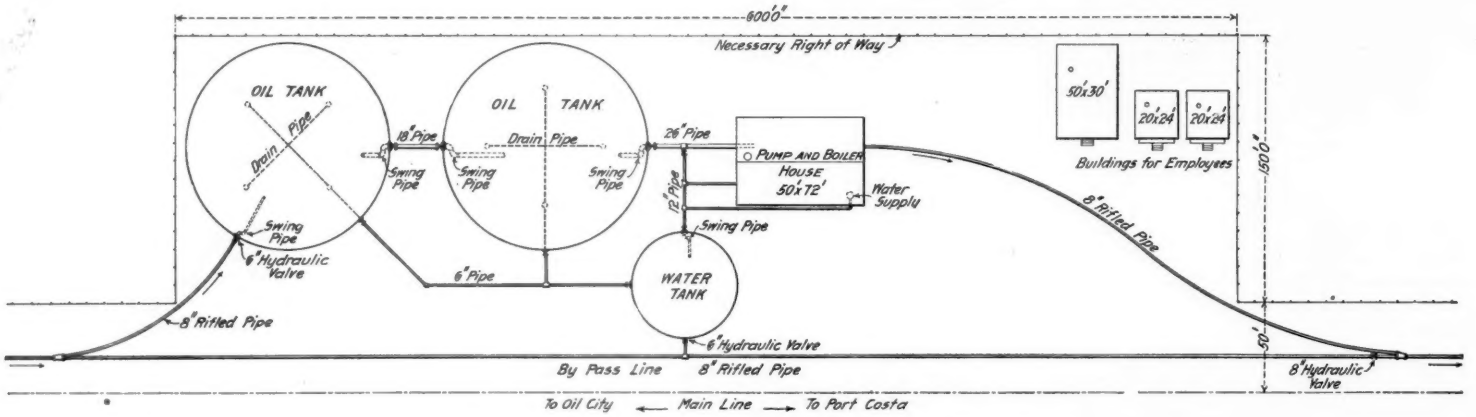
The new line will be 256 miles long, extending from Delano to Porta Costa, on the straits of Karquinez. These straits connect San Pablo bay, which is the upper part of San Francisco bay, with Suisun bay. It will be an 8-in. line, the same as the present one, and the pipe will be made by the National Tube Company. It will, however, be rifled hot, instead of cold after delivery as heretofore. There are to be 23 complete pumping stations on the line. A ground plan of the station layout, all 23 of which will be alike, is shown herewith. The principal station equipment comprises the boiler plant, oil pumps and water injection pumps. The accessories include electric lighting equipment and the usual feed pumps, feed-water heaters, piping, etc. The stations will contain a number of improvements, especially in the oil pumps, suggested by the experience with the existing line.

One of the peculiarities of the oil pumps in this process is that they require a much larger valve area in proportion to the size of the plunger than is usual with fluid pumps, to prevent cavitation in the plunger barrel; therefore the pumps contracted for are to have a valve inlet and outlet area each equal to the area of the plunger. The valves also must have a very limited lift, the maximum specified to attain the given area being ¼ in. If the lift is large the inlet valves will not close through the heavy viscid oil promptly enough and much of the oil is forced back into the suction instead of into the discharge. The water injection pumps are nearly in accordance with standard hydraulic practice; however, they are made quite large in proportion to their required capacity of discharge, as it has been found of great advantage in this system of pumping to insure a very steady and uniform flow without surging or irregular motion in the pipe line. All of the apparatus is to be in duplicate, and each part of each piece of apparatus is to be interchangeable with the like part in every one of the 23 stations. All like parts are to be made to templet and gage for all stations. Another special feature of the station arrangement is that the oil and water pumps are to be installed in duplicate instead of triplicate. The purpose is to run all the pumps all the time, at less than the maximum capacity of each but at maximum efficiency. They will be so connected, however, that in case a pump is stopped from breakage or any other cause, its duplicate immediately and automatically assumes the entire load at quickened speed, and therefore at some cost in efficiency. The station buildings are to be made some longer than originally planned, as the oil pumps are to be given a greater number of valve pots than at first provided in the plans, increasing their length and therefore that of the enclosing building. The boiler plant for each station will be of 750 h.p. capacity in three equal units, the equipment to be of the Edgemoor water-tube type.

The daily capacity of the system is estimated at 23,000 barrels for 24 hours. There is storage capacity at each station for a maximum of five days' supply of oil. In the event of a break in the pipe the line can continue in use on each side of the break for about two days and a half; that is, from the initial point to the station preceding the break, and from the station beyond the break to the terminus, and the tanks will be kept about half full all the time while running. These tanks are steel, two at each station, with a capacity of 55,000 barrels each. There is also a water tank holding 10,000 barrels.

The oil entering a station through the rifled pipe passes into the first of these storage tanks and the line water almost entirely settles from the oil. It is then drawn, through a swing pipe, into the second tank where practically all of the remaining water separates from it. The pump suctions are connected to this tank, drawing the oil through a swing pipe. The discharge swing pipes in these tanks are automatically maintained so that the pipe always delivers at the level marking the division of oil and water, facilitating separation. The water from each of the oil tanks is bled into the water tank from which the water injection pumps draw their supply.

The contract requires that for every other station, one oil pump, one injection pump and two boilers shall be ready in nine months; and that the remaining stations be this far advanced in 14 months. The entire installation is to be complete in 18 months. As soon as the first condition above noted is fulfilled, the line will be put into operation, running at reduced capacity, of course. The present contract is for all apparatus within the station buildings, except the foundations up to the ground level, which are to be provided by the company. The amount of the contract is $1,448,785. The total cost of the line will be between $4,000,000 and $5,000,000. We are indebted to John D. Isaacs, Consulting Engineer of the Southern Pacific, for the foregoing information.



Layout for Pumping Plant; Southern Pacific Company's Rifled Pipe Line.

Rail Corrugation on English Electric Lines.

The Institution of Electrical Engineers (London, Eng.,) devoted its sitting on March 21st to a consideration of the rail corrugation question which is one of the most puzzling problems with which the traction engineer has been called upon to deal. Some efforts have been made to ascertain the extent of corrugations on English street railway systems, and the views of the managers of these lines as to the probable cause, according to the evidence at their disposal. But the great diversity of opinion expressed by these authorities points to one or both of two things, i.e., that insufficient experience has been obtained to enable many to arrive at a right conclusion, and that a very careful and precise tabulation and analysis of available information is very necessary.

The matter was introduced at the above meeting by Joseph A. Panton, an electrical engineer who has had some years practical experience on the Liverpool Overhead Electric Railroad.

The present practice of grinding rails (and money) away was described as only a partial remedy which did not enable us to make headway toward finding the actual cause of the trouble. Recent experiments with rail-grinders had turned out more or less unsuccessful. After grinding, corrugations soon reappear, thus indicating that it is to the equipment directly or indirectly in contact with the rails that we must look, and not to the rails themselves, for the cause.

It was stated that enough evidence had been accumulated to

contradict any theory that the quality of the rail accounted for the presence of corrugations. Some reasons stated were:

(1.) Because rails manufactured by every firm in the world have corrugated since the advent of electric traction.

(2.) That the rails did not corrugate in the days of horse and steam cars.

(3.) That the check rails are corrugated to an equal degree, and parallel to that on the crown of the rail.

(4.) That rails did not corrugate so long as the armatures were built on the axle.

(5.) That it takes on the average three years to develop corrugations on a new system, and only three weeks on relaying with new rails thereafter.

(6.) That an ordinary railroad rail taken from the straight road of an electrically-operated railroad (no corrugations occur) and relaid on a checked curve soon corrugates.

Mr. Panton said that there was absolutely no foundation for the statement that the trouble was due to the chattering of the rollers at the rolling mills, owing to play in the pinions and bearings of the rolls driven by antiquated steam engines.

He referred next to the probability of defects in rolling stock being the cause, his attention having been drawn to this point three years ago by the action of a flanged brake block then being tried to keep down wheel flanges. This and subsequent investigation and experience led him to the conviction that corrugations are caused, directly or indirectly, by lateral play in weak trucks, the weakness being intensified by unsymmetrically driven axles. On the Liverpool Overhead line during the first nine or ten years of its existence, when the armatures were built on the axle, whereby a symmetrical drive was obtained, there was no sign of any corrugations. But, on introducing single ended geared axles into the same bogies, a series of difficulties cropped up when running over the same rails, necessitating the renewal of rails on checked curves —a serious additional expense. Mr. Panton says that at least 75 per cent. of present day electric railroad and tramway equipments in England are unsuitably mounted on trucks of weak design.

The roaring rails, found principally on Indian steam railroads, were said to have their trouble originated in much the same way as corrugations, namely, from defects in the rolling stock such as excessive play at the journals or longitudinal play between the journal box and pedestal, which would in time, by constant hammering, cause the sides of the truck frame to spread outwardly, at the same time distorting other parts of the frame connected therewith. Such faulty truck design, said Mr. Panton, allows the centrifugal forces to center at various points in the truck, thereby shifting the center of gravity horizontally, and causing unequal strains on the wheel flanges and unequal tires on the same axle.

In regard to truck design it was said to be necessary to give up the riveted and built-up construction of bogie frames, which were not capable of withstanding the excessive strains of single-ended gear-driven axles on modern high-speed electric railroads. It was entirely due to the weakness in bracing the two sides together, especially under the axle box, that trucks now in use were unable to withstand the severe side strain to which they were subjected. It would therefore be necessary to supplement the present trucks with suitable underframes well-braced on either side of the wheels in order to prevent the spreading and buckling of frames which was occurring, amounting in serious cases to 1½ in. For modern electric interurban services on railroads and tramroads, the motor truck must be more substantially designed in view of the different service as compared to that required from early tramroads. Solid forged side frames equally as strong under the axle box as over it, securely braced together, and capable of withstanding side strains and shocks in every direction by the use of journal springs to bring the load to the wheels without interfering with the easy action of the boxes in the jaws, and, if possible, by equalizing the weight on the frame before it was equalized on the wheels—these were among the essential points.

Mr. Panton mentioned that his observations, however erroneous they might seem, and however crude his remedies, they were the direct result of practical experience gained since the year in which accelerated electric railway traction made a substantial start.

He suggested that the entire corrugation question should be finally settled and tested by a full technical investigation carried out either by the Board of Trade or by a Royal Commission.

In the discussion that followed the reading of the paper there was noticeable the same diversity of opinion that has already been mentioned.

Compression in Locomotive Cylinders and Means for Its Relief.

BY H. G. MANNING,
Assistant Chief Engineer, Crucible Steel Co. of America.

The object of this paper is to call attention to compression in locomotive engine cylinders as demonstrated by the St. Louis tests made by the Pennsylvania Railroad which stand as the most modern, complete and elaborately made tests presented to locomotive engineers. The writer desires to show:

First.—That compression in modern locomotive cylinders is excessive, particularly at the time the engines are exerting the average power.

Second.—That this excessive compression in locomotive cylinders far exceeds the necessary compression, as demonstrated in stationary engine cylinder practice, in which the shocks to machinery are as severe as in locomotives, and in which the point of exhaust closure is constant.

Third.—That relieving the excessive compression in locomotive cylinders will result in economy of fuel or greater hauling capacity.

Fourth.—That a relief valve having a constant point of compression for all points of cut-off of the valve gear will produce the results desired.

Table I with its accompanying indicator cards, all taken from locomotives tested on the Pennsylvania Railroad testing plant at the St. Louis Fair, gives results which are being duplicated in general railroad practice to-day. Comparing locomotive and stationary engine practice in regard to amount of compression necessary for smooth and economical running, Figs. 1, 2 and 3 are average conditions. Fig. 1 shows an indicator card taken from a locomotive making 190 revolutions per minute and cutting off steam at an economical point. The cylinders are 18 in. x 24 in. and the drivers 70 in. in diameter. It is the average card of a series of tests on the road, extending over two weeks, with the same route, same time and practically the same train in express service.

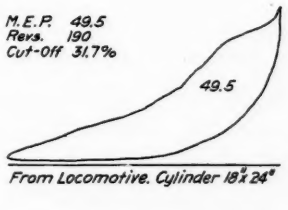


Fig. 1.

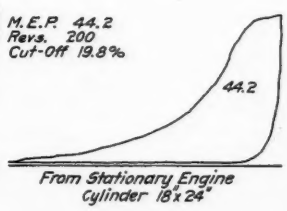


Fig. 2.

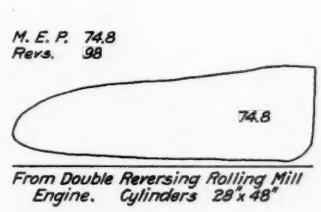


Fig. 3.

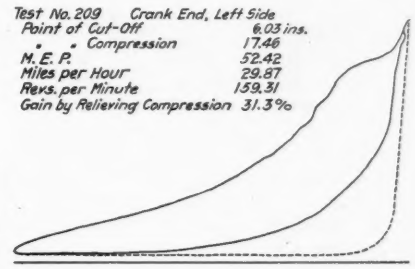

Test No. 209 Crank End, Left Side
Point of Cut-Off 6.03 ins.
" " Compression 17.46
M. E. P. 52.42
Miles per Hour 29.87
Revs. per Minute 159.31
Gain by Relieving Compression 31.3%

Fig. 4.

For 98.7 per cent. of the time the throttle was open, the average point of cut-off was as shown, and this card shows plainly the excessive compression this engine worked under in every-day service for practically 99 per cent. of the time it was using steam. This card is not an extreme, but represents squarely and fairly the ordinary running conditions of a passenger locomotive. This engine was using something more than 30 per cent. of the steam actually needed to perform the work, as will be shown later in the article.

Fig. 2 shows a card from a stationary engine having a constant point of compression, running 200 revolutions per minute, having the same stroke, and practically the same diameter of cylinder, with a greater piston speed than the locomotive from which card Fig. 1 was taken, and the amount of compression necessary for smooth running is clearly shown on the card.

Fig. 3 is a card taken from a stationary double reversing engine with cylinders 28 in. x 48 in., having at times a piston speed equal to a locomotive running 70 miles per hour, with a Stephenson link motion and rocker arms, identical with a locomotive valve motion in every respect, reversing on an average five times per minute, or 300 times per hour, 20 hours out of every 24. This work is equivalent to 420,000 miles per year if the engine was running on a rail, with common diameter of drivers, and this particular engine has done this for nine years. During this time the piston heads and rods have not been removed from the cylinders or crossheads, and the running repairs are exceedingly light.

Is compression more necessary on a locomotive than on this

engine with vastly greater shocks to machinery than ever occur in a locomotive outside of a collision?

If the defenders of excessive compression will simply admit what is a fact, namely, that the locomotive valve motion will not permit any reduction, then the matter becomes clear. Excessive compression in a locomotive exists because it cannot be avoided with the present design of valve motions.

The stationary engine cards show proper compression, and the engines run smoothly without detrimental shocks from lack of compression. What is done in stationary engine practice, as shown in Figs. 2 and 3, can be accomplished on a locomotive with the resultant economy in a simple and practical way, by using a compression relief valve of a design shown further on, that it is well to consider in these days of getting all that is possible out of a locomotive.

Fig. 4 shows in full lines a card taken at the St. Louis tests by the Pennsylvania Railroad from a simple locomotive running only 29.83 miles per hour, making 159 revolutions per minute.

The dotted lines show the possibilities if the compression is relieved to the same amount used in stationary engines having greater piston speed. This card shows an increase by relieving compression of 31.3 per cent. in M. E. P. with the same volume of steam taken from the boiler. This means that practically one-third more load can be hauled for the same quantity of steam generated, or the same load can be hauled for a less quantity of steam. As an example, suppose that two-thirds of the above increase in M. E. P. is realized by relieving compression. This means that a freight locomotive hauling, with compression, a load of 2,000 tons. can by relieving compression haul 2,400 tons, or six to eight more cars to the train. The profit on the extra freight hauled one trip would pay for the installations of a compression relief valve.

It will be noticed from the table that at speeds from about seven miles to 30 miles per hour, the average increase in M. E. P. by decreasing compression as shown by the indicator cards, is practically 11 per cent., or about 5 per cent. at the slower and 14 per cent. at the higher speeds. At speeds from about 40 miles to 75 miles per hour the average again is about 41 per cent., or about 17 per cent. at the slower to 60 per cent. at the higher speeds.

In this connection it must be understood that the high speeds were made from compound engines with the correspondingly longer cut-off in the high-pressure cylinder than would be the case on the simple engine doing the same work.

Summing up, the Pennsylvania tests show that on simple freight engines at speeds from seven to 30 miles per hour an average gain of about 11 per cent. can be made in M. E. P. for the same point of cut-off, and on compound engines at speeds from 40 to 75 miles per hour a gain of about 40 per cent. by decreasing compression in the cylinders.

The indicator card in Fig. 1 is an excellent example of the average running condition of simple passenger engines and the gain in M. E. P. by decreasing the compression to what we know is practical for a locomotive of 33.7 per cent. is worthy of notice.

The writer does not wish to be understood as claiming originality in bringing forward the decreasing of compression on locomotives. The intelligent student of the locomotive well knows the many designs of valve motions which have been tried to accomplish this object, but he also knows that any attempt to radically change existing locomotive valve motions has resulted in cumbersome devices which have soon shown their inferiority for continual service, although they admittedly released and compressed steam properly. It would therefore appear that any attempt to radically change the design has resulted in failures which the relief valve described below overcomes.

To relieve compression the writer has designed and put into use on many stationary engines, both high and low speed, a compression relief valve, receiving its motion from the main valve motion of the engine. Fig. 5 shows its adaptation to a locomotive with the Stephenson valve gear, in which the relief valve stem receives its motion from the "go ahead" eccentric rod or its equivalent, and Fig. 6 to a Walschaert gear, in which the relief valve stem receives its motion from the lower end of the link.

Fig. 7 is a cross section of relief valve in position on locomotive. Figs. 8 and 9 are average locomotive cards. Figs. 10 and 11 show the relief valve consisting of a simple slide valve, opening only the exhaust ports, having the same travel and angular advance for all points of cut-off, the ports leading to it from the cylinder entering underneath the valve, and the exhaust cavity connecting with main exhaust pipes of the locomotive.

The valve also becomes an automatic water relief, as the flat valve rises under any undue pressure, instantly relieving the cylinder and heads. The cylinder cocks can be used as at present, if thought necessary. The valve is in use on stationary engines which have been greatly troubled with water in the cylinder, in spite of separators, and good pipe covering, where it was necessary to keep the cylinder cocks open all the time, but since the relief valve was

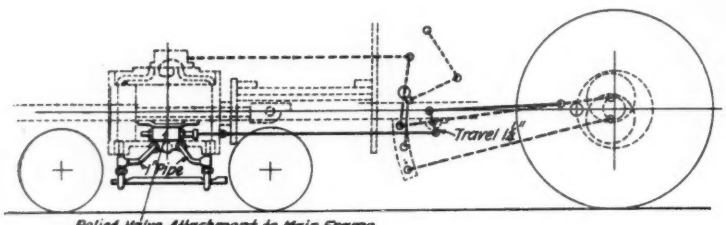


Fig. 5—Stephenson Link.

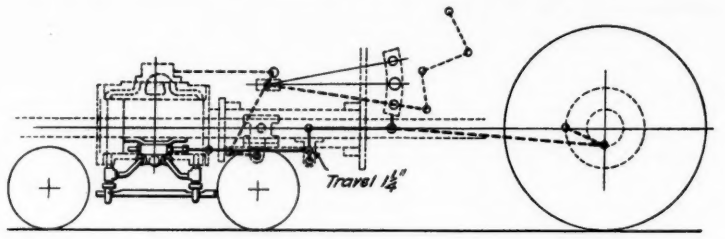


Fig. 6—Walschaert Link.

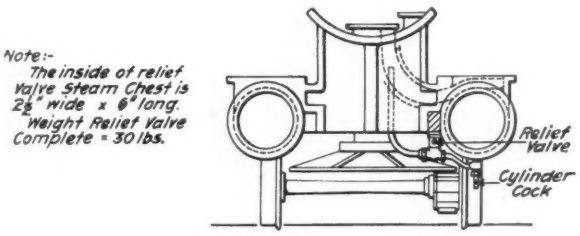

Note:-
The inside of relief Valve Steam Chest is 2½" wide x 6" long.
Weight Relief Valve Complete = 30 lbs.
Relief Valve
Cylinder Cock

Fig. 7.

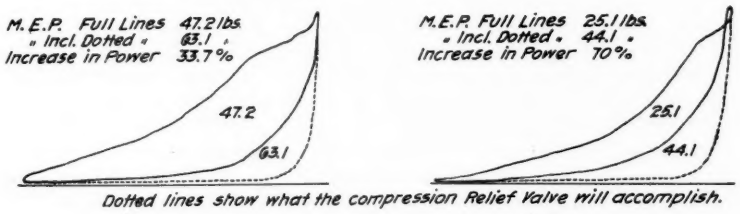

M.E.P. Full Lines 47.2 lbs.
" Incl. Dotted " 63.1 "
Increase in Power 33.7%
47.2
63.1
M.E.P. Full Lines 25.1 lbs.
" Incl. Dotted " 44.1 "
Increase in Power 70%
25.1
44.1
Dotted lines show what the compression Relief Valve will accomplish.

Fig. 8. Fig. 9.

The Manning Compression and Water Relief Valve as Applied to Locomotives.

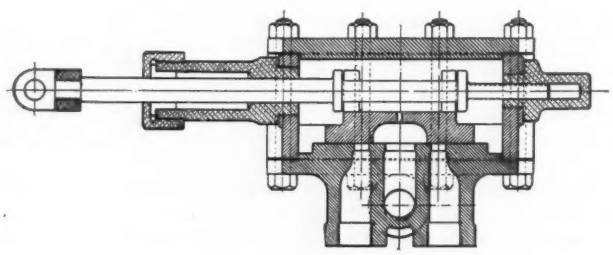


Fig. 10.

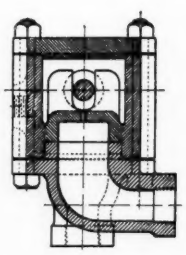


Fig. 11.

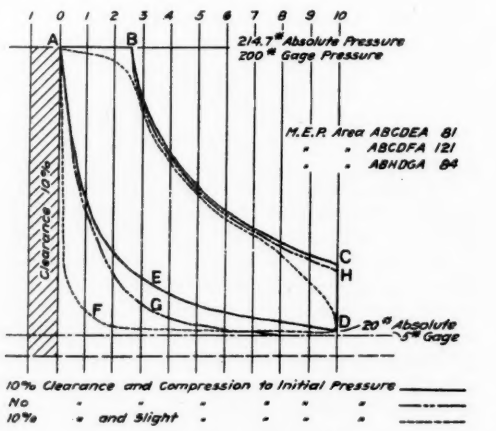


Fig. 12.

applied and the cylinder cocks taken off there has been no trouble, and the saving in steam was shown immediately on the coal sheets.

On a 20 in. x 26 in. cylinder the pipes leading to the relief valve should be not less than 1¼ in. On a cylinder with 10 per cent. clearance the increase in clearance is about one-quarter of 1 per cent. of the cylinder volume, an amount hardly large enough to mention. On a locomotive carrying 200 lbs. pressure and realizing 195 lbs. in the cylinder for an initial pressure the direct pull on the valve stem of the relief valve is about 50 lbs., a stress so slight that it might be disregarded as far as repairs are concerned. The balancing pressure on top of the slide valve is held at practically 40 lbs. per sq. in. when engine is up to speed, by the admission of steam to the small chest through a small hole drilled through exhaust cavity of the relief slide valve.

This balancing steam takes no useful steam as it comes only from the exhaust. The rushing through this hole of the exhaust pressure at each exhaust of engine, and the minute time the steam from the small chest has to escape, keeps the pressure in the small chest practically constant, determined by the size of hole drilled in exhaust cavity. An indicator card from the small steam chest draws a practically perfect straight line, showing beyond a doubt that the pressure can be kept constant.

The valve needs no oil as the steam passing through it keeps the valve surface perfectly lubricated. The valve stem is packed with metallic packing and wears for a long period without leaking. The point of compression can be made to occur at any point of the stroke desirable, but when once set is constant for forward gear for all points of cut-off.

When the locomotive is running backward the relief valve is thrown out of action in the following manner. In the exhaust pipe leading from both cylinders is a very loosely fitted plug cock operated from the tumbling shaft of the locomotive. This plug cock motion is so arranged that the opening remains practically constant from full gear forward to mid gear. From mid gear to full back gear the plug cock is rapidly closed, and while cylinder pressure passes through the relief ports it does not pass to the atmosphere, as the plug cock is closed. Any other arrangement providing for the compression relief valve to act in both forward and back gears makes an undesirable complication of parts, and as a locomotive is built to run forward ordinarily, and only runs backward about 1 per cent. of its lifetime, the saving by the relief valve in forward gear covers the essential working time of the engine. The patent papers cover a relief valve driven by the main valve motion of engine, or its equivalent.

With this simple, inexpensive and practical device it is possible, with passenger locomotives, to pull in the neighborhood of 30 per cent. more load at the same speed, or the same load at the same speed for about 30 per cent. less fuel, and the cylinder will be protected against undue water pressure. A piston valve in place of the slide valve would relieve the compression but would not relieve the water pressure and would be constantly breaking packing rings and valve stems from this water pressure. Large high-speed engines are working with this relief valve at numerous rolling mills in the city of Pittsburg, Pa., district.

Reviewing the indicator cards of the article, the thinking engineer readily sees that in stationary engine practice as demonstrated in cards Fig. 2 and Fig. 3 it is perfectly feasible to run engines at high speeds with a degree of compression comparable with economy and without shocks of any detrimental nature to the engine machinery.

What is accomplished in stationary engine practice can be accomplished on a locomotive by the aid of the device shown, and the writer's own experience with locomotives has been that with the compression relieved as shown the economy is practically that shown by indicator cards.

It should be remembered that the most economical steam engines we have at work to-day are those on which the point of compression is constant for all points of cut-off, and a locomotive provided with a simple arrangement which accomplishes this will have an efficiency approaching very near to the best performance of stationary engines.

It might be well to remind our railroad friends that Mr. Mark Baldwin, one of the best locomotive designers this world ever had, was averse to the adoption of the Stephenson link motion for the reason of the excessive compression obligated by its use, and did not build any engine with the Stephenson link until compelled to

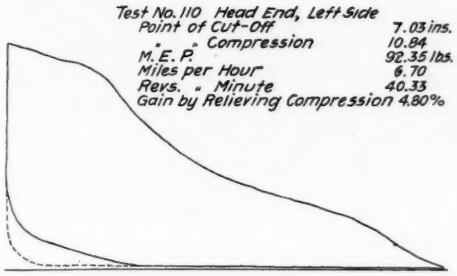

Test No. 110 Head End, Left Side
Point of Cut-Off 7.03 ins.
" " Compression 10.84
M. E. P. 92.35 lbs.
Miles per Hour 6.70
Revs. " Minute 40.33
Gain by Relieving Compression 4.80%

Fig. 13.

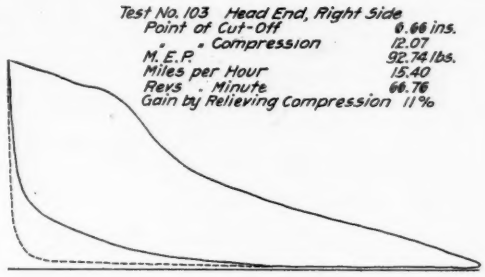

Test No. 103 Head End, Right Side
Point of Cut-Off 0.66 ins.
" " Compression 12.07
M. E. P. 92.74 lbs.
Miles per Hour 15.40
Revs. " Minute 66.76
Gain by Relieving Compression 11%

Fig. 14.

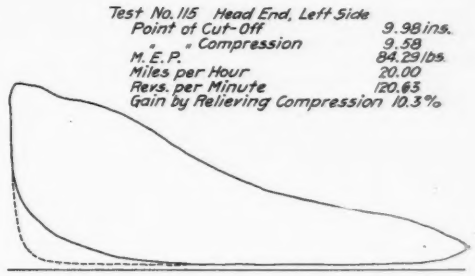

Test No. 115 Head End, Left Side
Point of Cut-Off 9.98 ins.
" " Compression 9.58
M. E. P. 84.29 lbs.
Miles per Hour 20.00
Revs. per Minute 120.63
Gain by Relieving Compression 10.3%

Fig. 15.

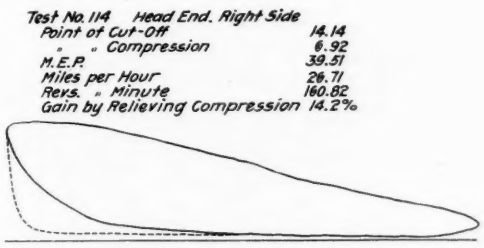

Test No. 114 Head End. Right Side
Point of Cut-Off 14.14
" " Compression 6.92
M.E.P. 39.51
Miles per Hour 26.71
Revs. " Minute 160.82
Gain by Relieving Compression 14.2%

Fig. 16.

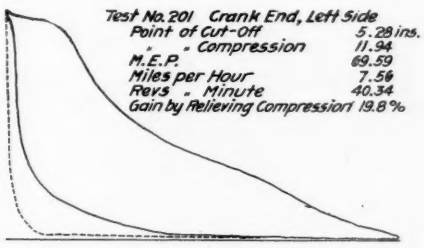

Test No. 201 Crank End, Left Side
Point of Cut-Off 5.28 ins.
" " Compression 11.94
M.E.P. 89.59
Miles per Hour 7.56
Revs " Minute 40.34
Gain by Relieving Compression 19.8%

Fig. 17.

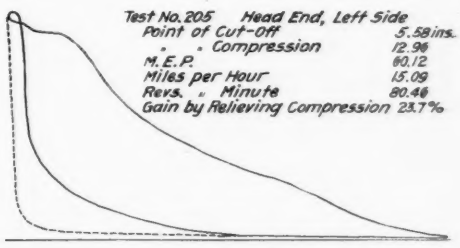

Test No. 205 Head End, Left Side
Point of Cut-Off 5.58 ins.
" " Compression 12.96
M.E.P. 80.12
Miles per Hour 15.09
Revs. " Minute 80.46
Gain by Relieving Compression 23.7%

Fig. 18.

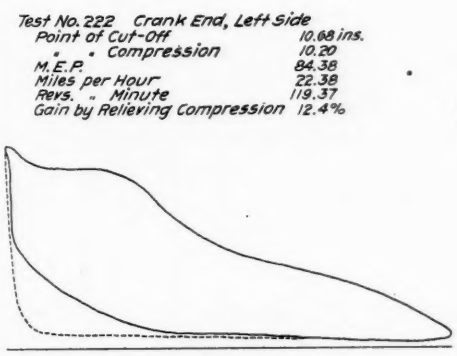

Test No. 222 Crank End, Left Side
Point of Cut-Off 10.68 ins.
" " Compression 10.20
M.E.P. 84.38
Miles per Hour 22.38
Revs. " Minute 119.37
Gain by Relieving Compression 12.4%

Fig. 19.

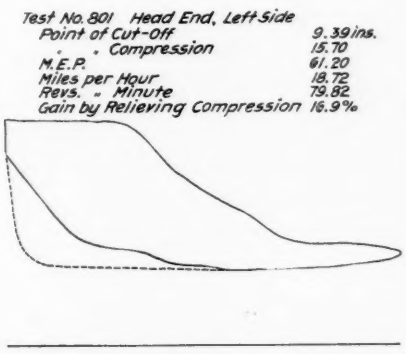

Test No. 801 Head End, Left Side
Point of Cut-Off 9.39 ins.
" " Compression 15.70
M.E.P. 61.20
Miles per Hour 18.72
Revs. " Minute 79.82
Gain by Relieving Compression 16.9%

Fig. 21.

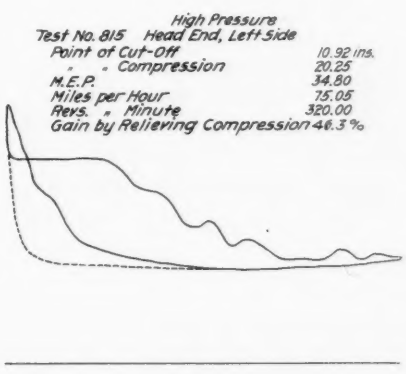

High Pressure
Test No. 815 Head End, Left Side
Point of Cut-Off 10.92 ins.
" " Compression 20.25
M.E.P. 34.80
Miles per Hour 75.05
Revs. " Minute 320.00
Gain by Relieving Compression 46.3%

Fig. 22.

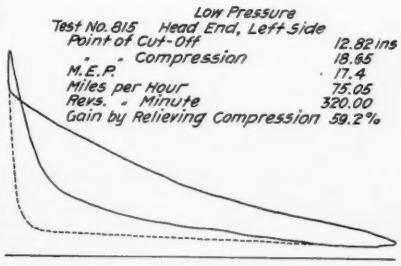

Low Pressure
Test No. 815 Head End, Left Side
Point of Cut-Off 12.82 ins
" " Compression 18.65
M.E.P. 17.4
Miles per Hour 75.05
Revs. " Minute 320.00
Gain by Relieving Compression 59.2%

Fig. 23.

do so by the railroad officials. Baldwin's own valve motion, which had the point of compression constant for all points of cut-off, was as economical in the use of steam as any motion ever applied to a locomotive, but it was considered cumbersome, and the Stephenson link appealed to railroad engineers as being simple, which, indeed, it is, but nevertheless in the writer's opinion we are sacrificing economy for simplicity, and the application of a device which can at its worst give slight trouble in repairs for long periods, should be considered seriously.

In the past, in order to be more economical in the use of steam we have thought it wise in the compound locomotive to practically double the troublesome working parts. In the writer's opinion more can be gained by relieving the compression in locomotive than by compounding, and the cost of relieving compression is so slight as to be scarcely mentioned in comparison with the necessarily high cost of compounding.

To those interested in the theoretical side we refer to Fig. 12, which shows expansion and compression curves drawn according to Mariotte's law, in which no heat is given out or taken up by the steam in expanding or compressing. The card has 10 per cent. clearance volume, 25 per cent. cut-off with 200 lbs. gage pressure.

It will be noticed in round numbers that the loss with 10 per cent. clearance and compression to initial pressure is about 4 per cent. over that of no clearance and compression to initial pressure, theoretically.

The relieving of compression results in a theoretical gain as follows:

Gain in M. E. P/ by relieving compression,

$$\frac{121 - 81}{81} = 49.5 \text{ per cent.}$$

which is reduced in practice to practically what the indicator cards show.

TABLE I.—*Taken from Pennsylvania Railroad St. Louis Tests.*

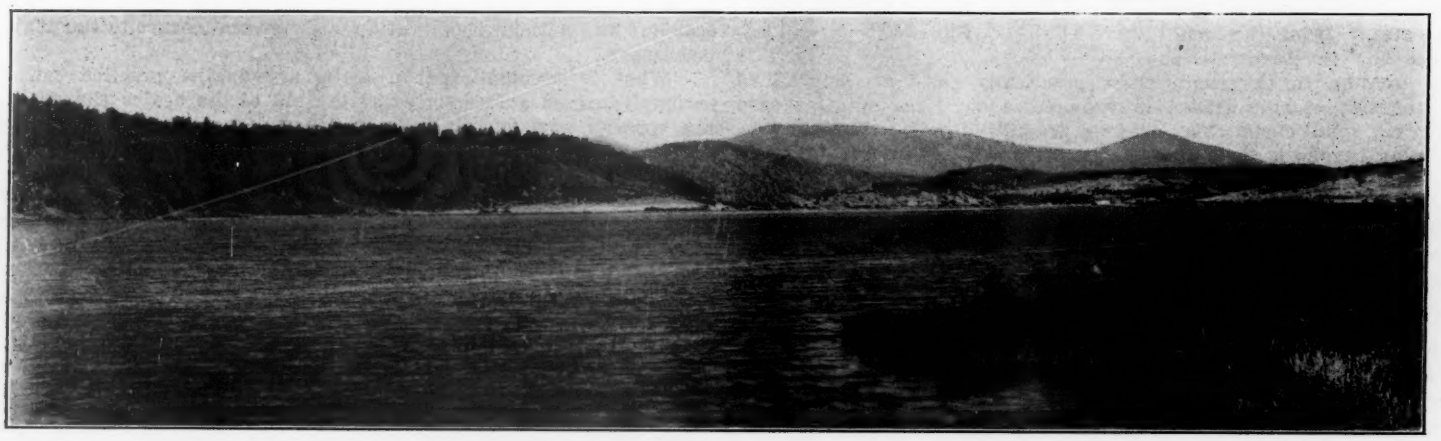
Itm.	No. of test.	Average indicator card.	Dimens'ns of cylinder.	Miles per hour.	Revolutions per min.	Apparent point Of cut-off in.	Apparent point Com-press'n, in.	Point of compression with relief valve, in.	Gain M.E.P. with compression relieved, per cent.
1.	110.	Fig. 13..	22 x 28	6.7	40.3	7.03	10.84	3.00	4.8
2.	103.	" 14..	22 x 28	15.4	92.7	6.66	12.07	3.00	11.1
3.	115.	" 15..	22 x 28	20.0	120.6	9.98	9.58	3.00	12.7
4.	114.	" 16..	22 x 28	26.7	160.8	14.14	6.92	3.00	14.2
	Average			17.4	103.6	9.45	9.85	3.00	10.7*
5.	201.	Fig. 17..	21 x 30	7.6	40.3	5.28	11.94	3.00	19.8
6.	205.	" 18..	21 x 30	15.1	80.5	5.58	12.96	3.00	23.7
7.	222.	" 19..	21 x 30	22.4	119.4	10.68	10.20	3.00	12.4
8.	209.	" 4...	21 x 30	29.9	159.3	6.03	17.46	3.00	31.3
	Average			18.7	99.9	6.89	13.14	3.00	21.8*
9.	801.	Fig. 21..	15.5x 26	18.7	79.8	9.39	15.70	3.00	16.9
10.	815.	" 22..	15.5x 26	75.1	320.0	10.92	20.25	3.00	46.3
11.	815.	" 23..	26 x 26	75.1	320.0	12.82	18.65	3.00	59.2
	Average			56.27	239.9	11.04	18.20	3.00	40.8

*Average, 16.3 per cent.

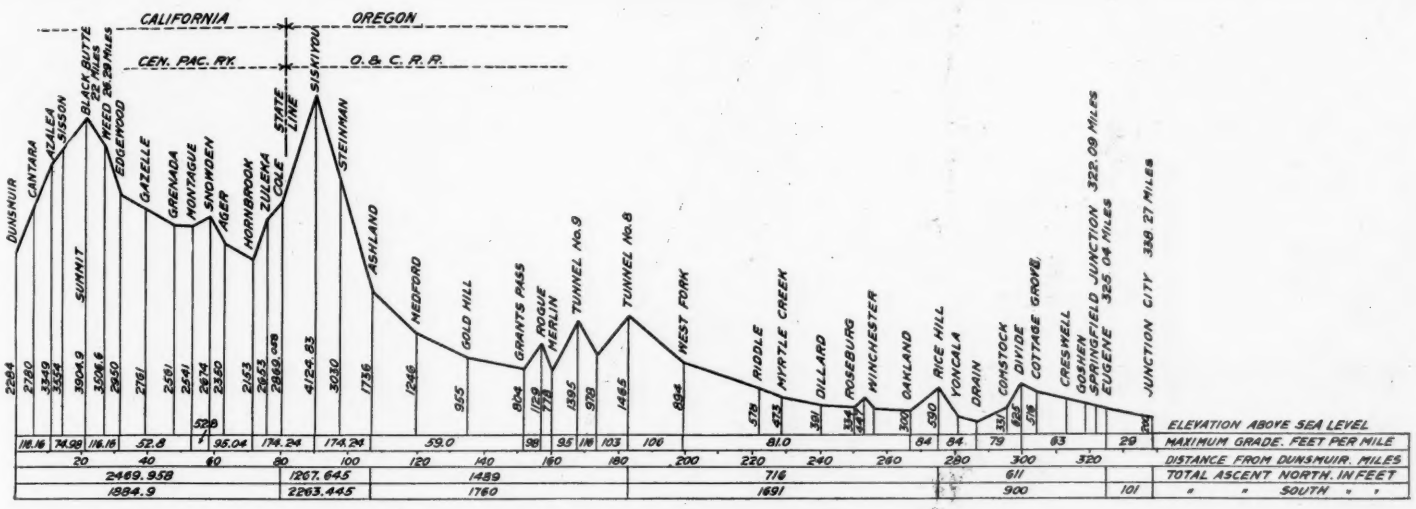
The Proposed Klamath Falls Line of the Southern Pacific.

The "Shasta Route" of the Southern Pacific, which is the line from San Francisco to Portland, Ore., is famous for the scenic attractions in the splendid mountain country which it traverses. It was completed some 20 years ago, when the Oregon & California, which is the name under which the lines in Oregon were built, was extended to connection with the Central Pacific at the California state line. The Southern Pacific acquired control of the Oregon & California shortly after its completion. The topography of the country traversed is extremely rugged, and the line is for the most part one of heavy grades and curvature. These attain a maximum in the Siskiyou mountains, lying approximately east and west adjacent to the Oregon-California boundary, where the railroad attains an eleva-

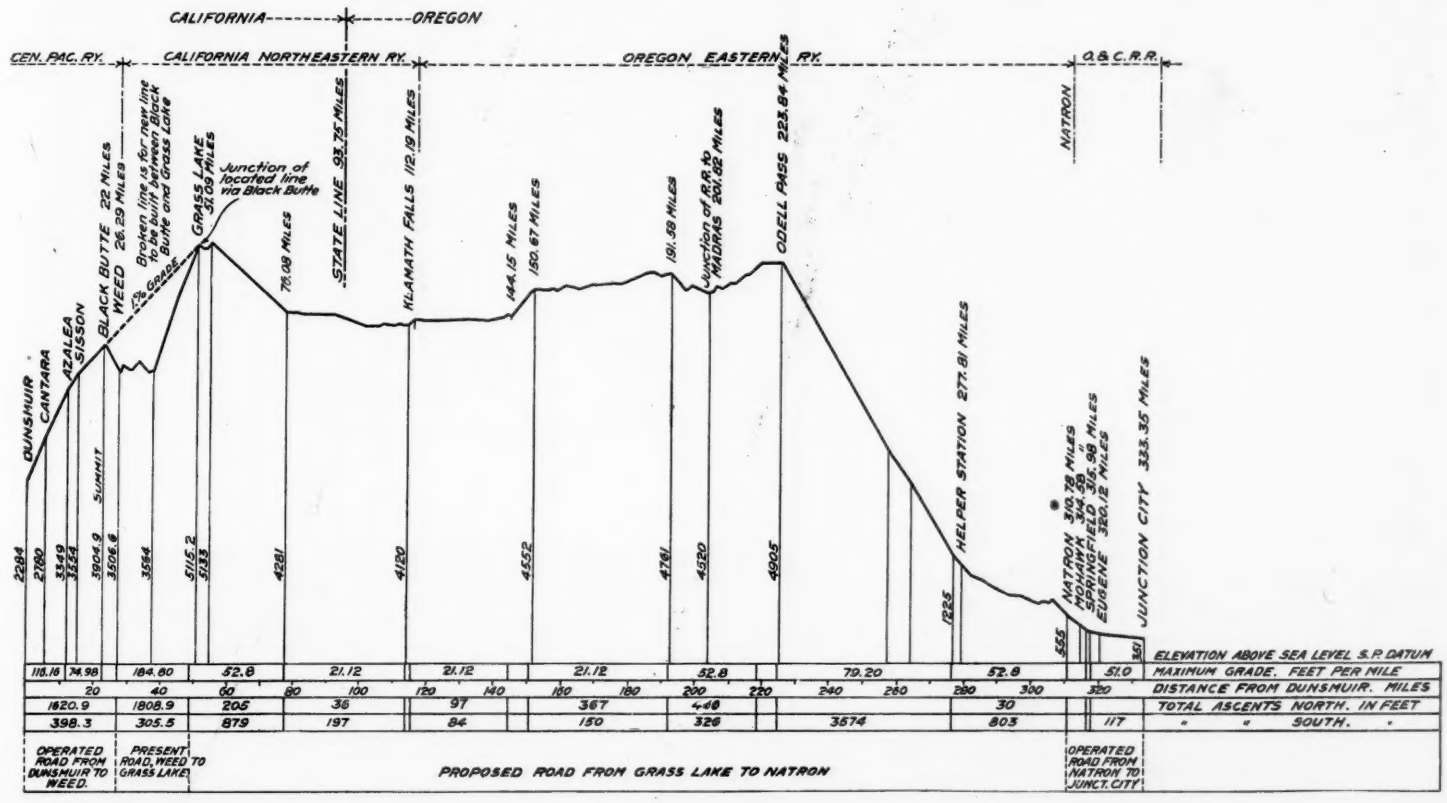
Map of Proposed Klamath Falls Line.



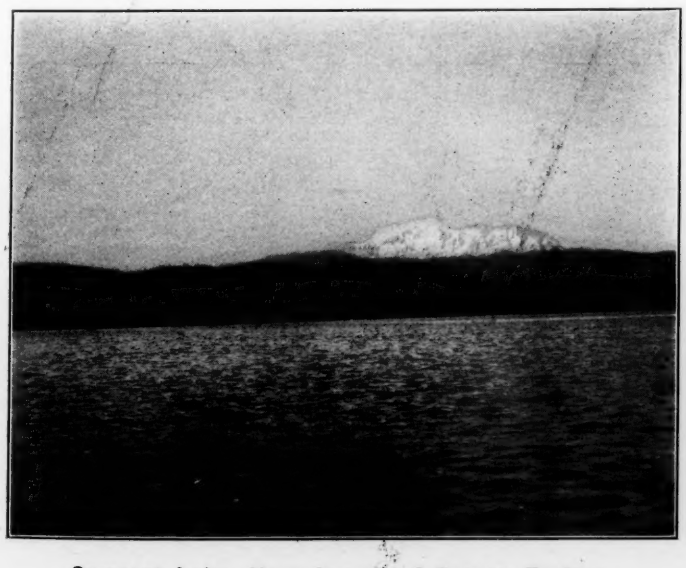
Upper Klamath Lake, Looking West from Steamer Landing.



Condensed Profile of Present Line Between Dunsmuir, Cal., and Junction City, Oregon.



Condensed Profile of Proposed Line, Dunsmuir, Cal., to Junction City, Oregon.



Crescent Lake, Near Survey of Oregon Eastern.

Grass Lake Station.

tion of over 4,000 ft. at the station of Siskiyou, and reaches same by a continuous grade of 174.24 ft. per mile (3.3 per cent.) over a distance of 20 miles northbound and 17 miles southbound. There are also long grades of 116 ft. to the mile in northern California, where the summit at Black Butte is crossed at an elevation of 3,905 ft.

Relief from the difficulties which the physical characteristics of this section of the road impose are obtainable in only one way, that is by an alternative line east of the Cascade mountains, where a location permitting much more favorable grades has been made. This proposed new route is shown on the accompanying map. It is composed of the California & Northeastern, projected from Weed, Cal., to Klamath Falls, Ore., and a southeasterly branch of the proposed Oregon & Eastern, originally chartered to build from Natron east across the state of Oregon to connection with the Oregon Rail-

Timber Lands, Shore of Klamath Lake.

road & Navigation. Profiles of the present and proposed routes between Dunsmuir, Cal., and Junction City, Ore., are shown herewith. The California & Northeastern, originally an independent project and later acquired by the Southern Pacific, had already been built from Weed to Grass Lake, about 29 miles. It was only a logging road, however, of light construction with 3½ per cent. grades, and is to be rebuilt to a maximum gradient of 1 per cent., as the profile shows, and shortened about five miles by relocations. From Grass Lake north the new route will be on a high plateau, having an average elevation of 4,500 ft., to Odell's Pass, where it passes through the Cascades and follows the Middle Fork of the Willamette river northwesterly to Natron.

Between Black Butte and Springfield Junction, which are the limiting points for the new construction, the routes compare as follows:

	Line		
	Present.	Proposed.	Diff. in favor of new.
Distance, miles	300.09	290.2	9.89
Total curvature, degrees	36,023	23,158	12,865
Grade rise northward, ft. vertical	4,919	2,651	2,268
Grade rise southward, ft. vertical	8,370	6,115	2,255
Maximum grade, per cent.	3.3	1.5	1.8

Equating the curvature and grade rise to straight and level track, the difference through curvature and grade saved in favor of the proposed route is 28.59 miles. Hence the present road may be regarded as made up of an actual distance of 300.9 miles and 28.59 miles handicap, or 328.68 miles, as against 290.2 miles by the new route. This means that the cost of operation as affected by curvature, distance, and grade rise and fall, will be by the new route roughly about .88 of the cost by the present route. With the exception of the climb of 1.5 per cent. at the north end to get through the Cascades, the maximum grade on the new line will be 1 per cent. The locomotives now working on the present line will be able to haul trains about twice as heavy over the new route, and helper service will be required only on the 1.5 per cent. grade.

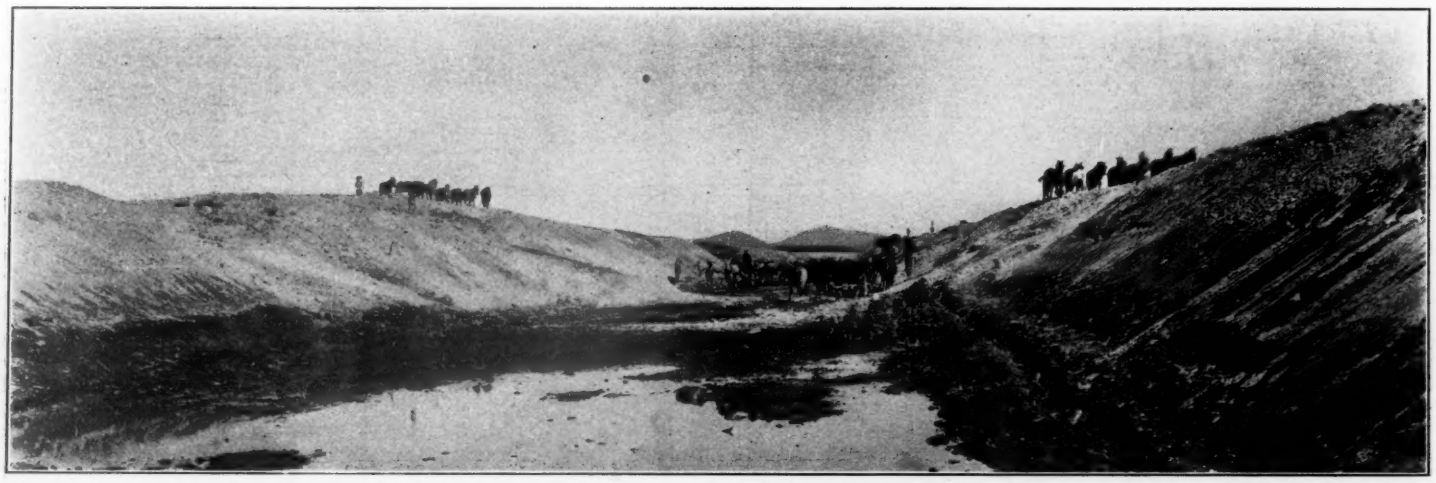
The territory which this new route will open up is rich in natural resources and has large areas of fertile lands. It has been practically undeveloped up to the present, with cattle and sheep raising the chief industries. The United States Government has now in progress a plan to irrigate and reclaim an area of 250,000 acres in the Klamath Basin. Half of this area is a marsh or completely submerged by shallow water. The irrigation work is well under way and the reclamation work will come afterward. These lands will produce alfalfa, grains, fruits and vegetables in abundance and of high quality. The climate is said to be delightful, with an abundance of clear days and no extremes of temperature. As soon as the railroad is ready for traffic, lumbering and its attendant industries will doubtless be among the chief activities of the region. The principal town on the route is Klamath Falls, between Upper and Lower Klamath lakes. It has a population of 2,500, and is the headquarters for the irrigation and reclamation projects of the region.

Work on the new line of railroad will be pushed as fast as practicable. It is expected to have the south end completed to Klamath Falls during 1908. Work on the Natron end will be begun this year. We are indebted to J. Kruttschnitt, Director of Maintenance and Operation of the Harriman Lines, for this information.

Superheated Steam on Locomotives.

At the recent meeting of the American Society of Mechanical Engineers, H. H. Vaughan, assistant to the Vice-President of the Canadian Pacific Railway, presented a paper in which he gave a resumé of the results that have been obtained on that road with locomotive superheaters. According to the author, the first application of superheated steam in North America was made by Mr. Roger Atkinson, then mechanical superintendent of the Canadian Pacific Railway, who applied a "Schmidt" smoke-box superheater to a 4-6-0 simple freight engine in 1901. In 1903 Mr. E. A. Williams, then mechanical superintendent of the same road, applied a "Schmidt" smoke-tube superheater to two 4-6-0 compound freight engines, and the results obtained from these installations were exceedingly satisfactory, the first engine showing a saving of 25 per cent. over corresponding simple engines and 18 per cent. over corresponding compound engines of the same class, while the latter engines showed a saving of from 15 per cent. to 20 per cent. over similar compound engines using saturated steam.

In 1904 the New York Central & Hudson River applied a "Cole-Field" smoke tube superheater to a 4-4-2 passenger



Government Irrigation Canal Near Klamath Falls, Oregon.

engine, and in the latter part of the same year the Canadian Pacific Railway purchased 41 engines, 21 of which were equipped with this type of superheater, and 20 with the "Schmidt" smoke-tube superheater. Since that date all engines, other than those in switching service, constructed on the Canadian Pacific Railway have been equipped with smoke-tube superheaters of various types, and on December 31, 1906, there were in service on this road 197 engines equipped with superheaters of the following types.

Type	No.
Schmidt smokebox	1
Schmidt smoke-tube	32
Cole-Field tube	21
Cole return bend	55
Vaughan Horsey return bend	88

At the present time this road has on order 175 locomotives for delivery during the present year, all of which are to be equipped with the "Vaughan-Horsey" type of superheater, which will make a total of 372 engines to which this principle has been applied.

On the railroads in the United States the progress has been far less rapid, and a reasonably complete list of the engines equipped at the end of 1906 is as follows:

Railways.	Cole.	Schmidt.	Vaughan-Horsey.	Total.
N. Y. C. & H. R.	1	..	..	1
Chic., Burl. & Quincy	1	2	..	3
Rock Island.	6	..	..	6
M., St. Paul & S. S. M.	1	..	..	1
Chic. & North-Western	1	..	..	1
Boston & Maine	1	..	..	1
Lake Shore & Mich. South	1	..	1	2
Totals	12	2	1	15

ECONOMICAL RESULTS.

The results obtained in coal economy have on the whole been exceedingly satisfactory. The results obtained from the first three engines on the Canadian Pacific Railway have already been referred to. Subsequent results on a large number of superheaters have not, however, shown as large a percentage of saving as would naturally be expected, when a device of this nature is applied in sufficient quantities to insure the engines with which it is equipped being treated in exactly the same way as other engines to which no particular attention is given and taking their chance with reference to the ability of the engine crews which handle them.

Unfortunately it is difficult to compare superheater simples with ordinary simples on the Canadian Pacific Railway, as previous to the introduction of the superheater most of the recent power purchased was of the compound type, and care has also to be exercised in making comparisons on account of the large variation in the coal consumed per ton-mile on the Canadian Pacific in the summer and winter.

The most satisfactory comparison is arrived at by taking engines working over similar sections during the summer months, and the following table shows the performance of 2-8-0 superheater simples as compared with similar 2-8-0 compound and a 4-6-0 compound of about equal weight and also similar in design. The superheaters are of two types. M-4a being a Schmidt smoke-tube return bend and M-4b a Cole-Field tube, M-3a are 2-8-0 compounds and D-9 a 4-6-0 compound. These results are those obtained during the summer of 1905.

The D-9 engines may also be advantageously compared against three classes of 4-6-0 simple superheater engines of the D-10a class equipped with Schmidt smoke-tube return bend, the D-10b with a Cole return bend and D-10c with a Vaughan-Horsey return bend.

These engines were run against each other during the months of September, October, November, December and January, inclusive, on the Canadian Pacific between Fort William and Winnipeg, and the general result is given in Table 2, with reference to which it should be noted that this section of the line is an exceedingly favorable one for compound locomotives.

Previous to the introduction of the superheater, the D-9 engines had been by far the most economical yet used on that section. The superior economy of the D-10c engines is not easy to explain, and although the writer has discussed this question at some length before the New York Railway Club, he does not feel that there is sufficient data on the subject to regard it as a definite fact.

	Section			
	Fort William to Ignace.	Ignace to Kenora.	Kenora to Winnipeg.	Total.
1300, D—9, Compound:				
Coal used	13,144	2,520	8,416	24,080
Relative consumption	100	100	100	100
700, D—10a Schmidt-Sup.:				
Coal used	207	6,073	2,170	8,450
Relative consumption	101.0	98.3	100.8	100.7
710, D—10b, Cole Sup.:				
Coal used	2,993	14,082	10,443	28,418
Relative consumption	88.5	105	100.5	99.5
740, D—10c, V.-H. Sup.:				
Coal used	5,842	...	...	5,842
Relative consumption	84.7	...	...	85.5

In the early part of 1906, the Cole superheaters were removed from the M-4 engines, and therefore during 1906 were used as simple engines, thus offering a good basis for comparison with the M-4a engines. This year some other classes of engines have been introduced. Two 4-6-0 simple passenger engines class E-5 have been converted to Vaughan-Horsey superheaters, class E-5d and some 2-8-0 simple engines class M-4e have been equipped with the same device, as well as some Pacific type 4-6-2, passenger engines class G-1-2. For purposes of comparison the results obtained from 2-8-0 class compound engines, M-1-2 of slightly smaller size than the M-4 are also shown. These engines are an economical and satisfactory type and offer a good basis for comparison.

In the majority of cases the superheater engines showed a decided saving, and the results between the 4-6-0 and 2-8-0 vary somewhat in accordance with the relative economy of these two general types of engines. Under some conditions the 2-8-0 are more economical, while under other conditions there is very little difference.

A very interesting result is that obtained from Field to Revelstoke. These are engines working on very heavy grades and are fairly comparable for two classes of locomotives involved, as they were both working together, and it will be noticed that a saving of 11 per cent. for the six months in favor of the superheaters was obtained. For the larger portion of this section the engines were working at long cut-offs where the gain from superheat would be expected to be less marked.

An interesting difference is shown between Swift Current and Medicine Hat. In freight service the D-9 freight compound engines show up exceedingly well in comparison with superheaters, but in passenger service on the same section the superheaters are much more efficient, the compound taking about 60 per cent. more coal, due to the loss in efficiency in the compound in passenger service and the relative gain in the superheater.

Tests on other roads so far as information has been received show in general a reasonable amount of saving. On the Chicago, Burlington & Quincy the road records show but little difference, and on this road the experience was not satisfactory, due very probably to trouble experienced with leakage at the joints in the headers.

On the Boston & Maine comparative tests of two 4-6-0 engines equipped with Cole return bend superheaters in passenger service showed a gain of 14.7 ton-miles per pound of coal on the engine equipped with superheated steam.

On the Chicago & North-Western tests comparing identical 4-4-2 passenger engines with and without Cole superheaters showed an economy of 9 per cent. in coal in favor of the superheater.

On the Lake Shore & Michigan Southern tests of engines equipped with Cole and Vaughan-Horsey superheaters compared to similar engines using saturated steam showed a saving of 18.8 per cent. for the Cole and 22.1 per cent. for the Vaughan-Horsey superheater in coal per ton-mile.

From the general results of these figures it would appear safe to state that from 10 to 15 per cent. saving is obtained in freight service and 15 to 20 per cent. in passenger service on engines equipped with superheaters as compared with those using saturated steam although this economy will be to a considerable extent lost if leakage occurs at the headers.

MAINTENANCE RESULTS.

Results obtained from superheaters on the Canadian Pacific Railway are such as to justify a continued construction of engines equipped with this device. The past three years have developed many troubles, but they have also indicated their remedy.

The automatic damper, first looked on as a desirable attachment, has proved to be a most important factor in the successful operation of the superheater engine. During the first year's experience it appeared to make but little difference whether this damper was operative or not, but it has been found that if neglected there is a gradual but serious deterioration in the ends of the superheater pipes. The structure of the metal becomes entirely destroyed and leaks occur at the return bends, and the metal in the pipes changes its structure until it can be broken in the hands. The damper is not difficult to maintain, simply requiring proper attention, but the design which has been used and which was introduced with the original Schmidt superheater is not satisfactory, and can certainly be very much improved, and its maintenance made easier.

The writer sees no reason whatever for abandoning a valuable and important principle such as the use of superheated steam because troubles have been incurred through neglect in maintaining a small attachment which could easily have been attended to had its importance been appreciated, and after three years' experience feels justified in stating that if the dampers are properly maintained the trouble through the destruction of the ends of the superheater pipes will not occur.

With properly maintained dampers the next source of trouble is leakage at the connections of the superheater pipes to the headers. In the Schmidt design properly put up, this occurs but very seldom, and the majority of engines with this arrangement will run from shopping to shopping without attention. The objection that has developed in the Schmidt arrangement is that should any leakage occur, especially in the flanges attached to the upper rows of superheater pipes, it is practically necessary to take down all the flanges and make the joints afresh, and this takes considerable time with a corresponding loss in the service of the engine.

The greatest trouble has come from having to do this on ac-

count of the leaks occurring at the return bends caused by dampers not being properly maintained, but apart from this trouble the writer considers the Schmidt to be a satisfactory design, although the inability to take out any defective element without disturbing others is to his mind a great objection.

The Cole type of superheater has given considerable trouble from leakage at the joints between the sub-headers and the main header. While this may be overcome by a modification in the design, the number of defects which have developed has been most serious. The joints are probably loosened by the action of the weight of the superheater pipes working backward and forward when the engine is in service, and the loosening of the joints causes a leakage of steam across the face of the copper gasket and rapidly cuts it away. Arrangements are now being made to support the lower ends of headers so as to prevent their movement, and it is thought that this will largely overcome the difficulty. No trouble is experienced in the joints between the superheater pipes and sub-headers, but the latter are difficult to take out one at a time without disturbing those adjacent, and thus in case of a defective superheater pipe it is generally necessary to make all the joints over again, which means considerable work.

The Vaughan-Horsey type gave considerable trouble at first on account of the fittings and union nuts being made of brass, which deteriorated in the heat of the gases, but since these parts have been made of steel, the trouble has been practically overcome, and on account of this design permitting any pair of superheater pipes to be withdrawn without disturbing another, a defective element can be taken out, the joints blinded, and the element replaced at the first convenient opportunity, which is of considerable advantage in roundhouse maintenance where engines are worked as hard and as continuously as they are in American practice.

In general the maintenance of superheaters has not proved expensive, but the troubles enumerated have led to annoying and inconvenient delays to power, which if not treated on their merits might be held to condemn the device, but when analyzed, there seems to be no insuperable difficulty in remedying these, and with the proper remedy the writer firmly believes there is nothing about a superheater which should lead to its giving a less efficient service than a simple engine, and the slight additional expense is amply warranted by the saving obtained.

The smoke-tubes have given but little trouble, in fact less trouble than the ordinary 2 in. or 2¼ in. tubes which they replaced. On some bad water districts where the small tubes have to be reset every 20,000 or 30,000 miles, the smoke-tubes can be allowed to run through at least one resetting of the small tubes, which is probably due to the considerably better circulation and their greater thickness. Some difficulty has been experienced from the smoke-tubes stopping up with cinders, especially with the Field-tube type of superheater which seems particularly bad in this respect. With the return bend type, however, on the majority of the roads there is no serious difficulty in this respect, although it is necessary to see that the tubes are properly and systematically blown out and kept clean. The expense in the labor involved in doing this is, however, negligible.

The maintenance of valve and piston rod packing is slightly greater on engines running with superheated steam than on simple engines, but with proper lubrication the difference is not serious. It is necessary to use hard close grained cast-iron for the valve and piston rings, but with suitable types of piston and valve stem packing there is practically no difference in the maintenance of simple and superheater engines.

In general, the writer believes that while it may be necessary to insist on the proper maintenance of superheaters the expense involved is not great, and with proper maintenance and the improvement in detailed design which experience is leading to, there will be practically no decrease in the mileage to be obtained from the superheater as compared to the simple engine, and that the additional cost of maintenance will be unimportant.

LUBRICATION.

When engines equipped with superheated steam were introduced, it was considered necessary to use forced lubrication to the valves and cylinders, and this belief led to considerable trouble owing largely to the various forced feed lubricators employed which did not work satisfactorily with their rapid wear and the small amount of attention they received from the enginemen. During the past year, however, it has been found that the ordinary hydrostatic sight feed lubricator is quite as satisfactory on engines using superheated steam as on those using saturated, but it is necessary with the oil at present employed to lubricate the cylinders in addition to simply lubricating the valves, as in common simple engines. The present practice is to use separate feeds to each end of valve and to center of cylinder near the top, and with this arrangement no difficulty is experienced with lubrication, although the writer believes it would be advantageous to use a rather heavier valve oil than is at present customary.

CONCLUSIONS.

The writer's experience with locomotives using superheated steam has not been free from vexations and annoying troubles, but it has on the whole been exceedingly satisfactory.

The troubles encountered are being overcome as experience develops their cause and the saving obtained is apparent in the reduction of the amount of coal used per ton-mile on various divisions of the road as superheater locomotives are introduced. The additional capacity of the engines and the reduction of the work required of the fireman, enabling trains to be handled better, and the development of an engine which in extremely cold weather can be as easily maintained as a simple engine with an economy equal or superior to that of a compound is an important advantage to any railroad working in northern latitudes.

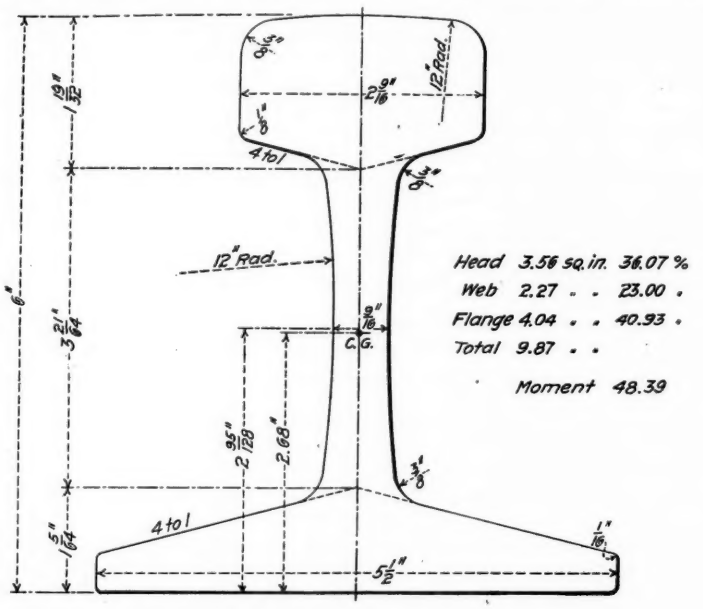
So far as can be seen at present there is no valid reason for discontinuing the application of superheaters, and the writer expects that a considerable increase in the number in use will take place in the next few years.

A Proposed New 100-lb. Rail Section.

One of the large railroad systems has adopted the 100-lb. rail section illustrated herewith, which was designed by Capt. Robert W. Hunt, of R. W. Hunt & Co., Chicago. Concerning the characteristics and advantages of this section its designer says:

The section differs quite radically from any now in use, particularly in the proportions of metal in the head, web and flange. In the very much lighter-sectioned rails, which under old conditions were the standard-weight ones, those proportions were not of so much importance, either from a user's or manufacturer's standpoint.

Railroad officials have generally insisted upon a large, or at least a deep head, arguing that as the wear of traffic was upon the



Proposed New 100-lb. Rail Section.

top and sides of the head, it was logical that the greater part of the metal should be located in that part of the rail. While this view is plausible, unfortunately it ignores metallurgical and manufacturing conditions. As the finished section of the rail is increased, so is the work upon the metal in it decreased, and, of necessity, the heavy rail, when it leaves the finishing rolls, contains more heat than the smaller-sectioned one. It is a well established fact that the work applied, and the temperature of the steel when receiving such work, are vital factors in regulating the structure, and hence quality of the finished article. Therefore to secure the best structural results it is important that the rail section should be one easy to develop in the rolls, and therefore requiring the minimum degree of heat. It is also important that the proportions of metal in the head and flange should be so balanced that as the rail cools it will remain as nearly as possible to a straight line and thus require the least possible amount of work under the cold straightening press.

In rolling steel it is much easier to elongate the metal than to spread it, hence the difficulty in producing rails with wide and thin edged flanges. This tends toward the practice of rolling and finishing the metal in such sections at too high a temperature for the best quality results. As the use of tie plates increases the necessity for very wide flanges decreases.

In a large percentage of recently broken rails of the heavier sections the fractures have occurred at the bottom of the web, extending longitudinally along and up through the flange, the pieces breaking out in crescent shape. In many instances such failures started at a seam or fold in the steel, which was formed in rolling

the rail and resulted from the spreading of the metal in that process in developing a wide and thin flange. The narrower and thicker flange of the proposed section should prevent this, and at the same time it is much strengthened at the point where such failures have occurred.

As renewed or re-rolled rails are giving satisfactory results, in designing the proposed section this subsequent rolling and use of the rail was kept in view, and it is believed that at least two satisfactory renewals can be made, leaving the last section weighing over 80 lbs. per yard.

Moment of Inertia and Curvature.

BY G. R. HENDERSON.

The recent distressing accident on the New York Central Railroad near Woodlawn has caused a great deal of interest to be taken in the mechanics of curvature, and it is probable that more attention has been given to this subject within the last three months than ever before.

The well-known work of the late A. M. Wellington, "Economic Theory of Railway Location," contained probably the earliest dis-

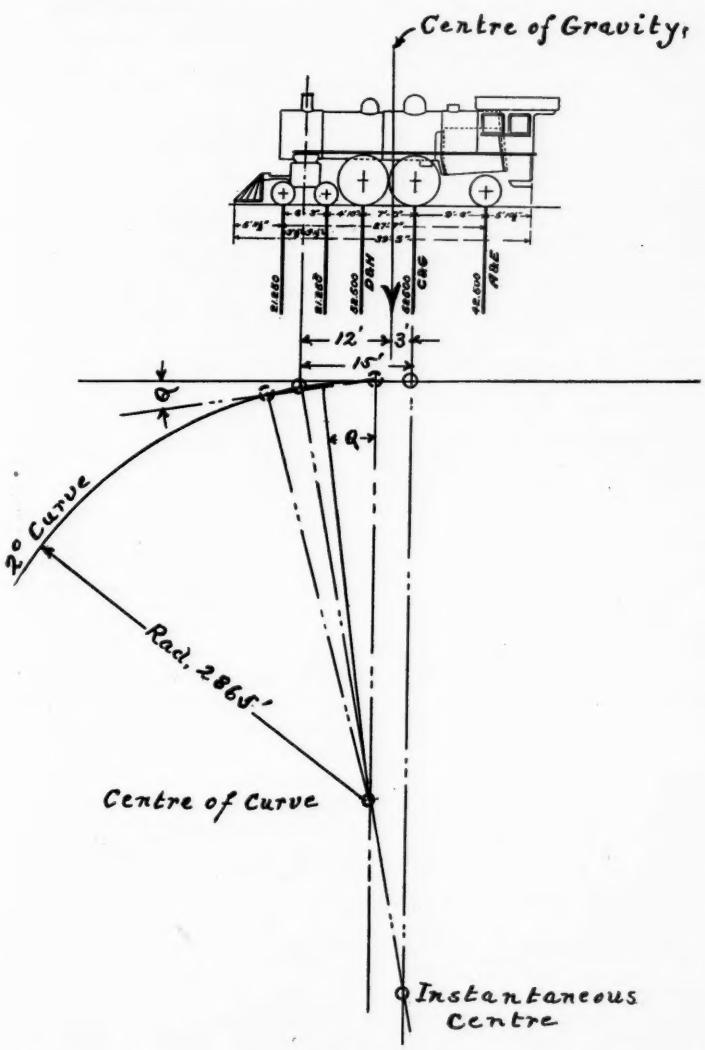


Fig. 1.

cussion of the effect of wheel and rail friction upon curve resistance, and Mr. Wellington explained in his work some experiments which he had made with models regarding the slewing action which takes place when any body with a rigid wheel base passes around a curve. The effect of centrifugal force is well-known and has been very thoroughly studied in connection with the question of superelevation of the outer rail.

Publicity having been given through the medium of the technical press to the calculations and analyses made by college professors and railroad experts upon the accident above referred to, the matter is placed before us in such a position that we feel free to add to the discussion upon this point. The reports that we have seen state that three fundamental principles of the mechanics of curve resistance were considered in making the computations. The first of these was the component of slipping in the direction of the rails due to curvature and was based principally on the coefficient of friction between the wheels and the rail, and was figured for the pressures with which the different wheels bore upon the rail. The second consideration was the component of slipping in the direction of the tangent of the track due to unequal rail lengths on the inside and outside of curve, and this was figured in a similar way as the first item. The effect of centrifugal force and its partial neutralization (as far as horizontal forces against the rail were concerned) by means of super-elevation were also considered.

These three forces, as far as our conception goes at the present time, and outside of various oscillations, vibrations, etc., due to irregularities of the track or intermittent reciprocating action of certain parts of the locomotive, include all the horizontal forces that act upon the locomotive, or in fact a car while passing around a curve of uniform curvature, but when the rate of curvature either increases or decreases, another force must be brought into play which, so far, we have not seen mentioned in any of the discussions upon this matter. Our attention was called to this by Mr. T. H. Brigg, but as far as known the writer is the first to work out the actual calculation of the amount of this force.

While attention may not have been brought specifically to the existence and the amount of these forces, they have been recognized by constructing easement or spiral curves at or near the point of tangency so that when a train enters or leaves a curve the sudden turning of the equipment in a horizontal plane is much reduced by the means of these easement curves.

Let us consider what happens when a vehicle traveling on a railroad enters a curve. We have already seen that when on the curve the centrifugal force comes into play, and also certain slipping of the wheels in order to make up for different lengths of rail on inside and outside of curve, and for the slewing of the engine; but if we consider that the vehicle enters the curve with a high velocity, it is apparent that in addition to these forces there is also the force of inertia of the vehicle itself to be overcome in causing it to turn in a horizontal plane. This is entirely separate from and independent of the centrifugal force, and as will be shown later is greatest when the centrifugal force is least, and vice versa. Any body traveling in a straight line desires by its inertia to continue traveling in that same straight line, and unless some force be applied, the axis of the body (if originally parallel to its line of travel) will also continue in the same line. In order to make this matter clear, let us consider that a car is propelled on a plane surface with loose wheels on the axles and without flanges. If it has a velocity in a certain direction, let us suppose parallel with its axis of shape, it will continue indefinitely in the same direction, but if we should wish to guide this body in a curve and instead of using a track, should attach a cord to its center of gravity and secure the other end of the cord to a fixed center, the body will describe a circle about that fixed center, but the axis of the body would continue to point in the original direction. This is similar to the constant direction of the polar axes of most of the planetary bodies, and in the case of certain members of our solar system, whose axes of rotation have a less inclination to the plane of their orbits than has the earth's, is more marked in its effect than in the terrestrial body which we inhabit. It is evident therefore that some force is needed when entering a curve to give the body or car an angular acceleration in a horizontal plane. This angular acceleration will commence when the front wheels strike the curve and will end when the last wheel enters the curve and the velocity will be constant while the radius of curvature remains constant, but when the curve is left and the next tangent entered the same process will be repeated in the opposite direction.

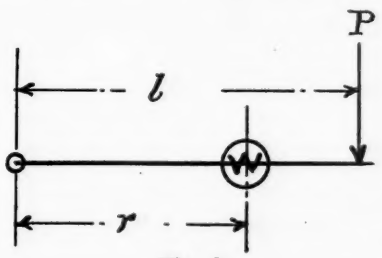


Fig. 2.

Referring now to the diagram, Fig. 1, let us consider a piece of track consisting of a tangent and a 2 deg. curve whose radius is about equal to 2,865 ft. Consider also an Atlantic type of engine, such as is shown in the diagram, to enter this curve at a velocity of 80 miles per hour, or 117 ft. per second. While on the tangent there will be no centrifugal force as the radius of a straight line is infinite, and the regular formula for centrifugal force is represented by a fraction whose denominator is a function of the radius of curvature. As soon as the front wheels enter the curve the locomotive begins to depart from its original path in a straight line, and the instantaneous radius of its curvature at any point can be determined by drawing normals to the track at the points of contact of the truck, and, if you please, the rear driving wheel which is the last point in the rigid wheel base. It is evident that the intersection of these normals will be the instantaneous center of curvature; and it is also evident that their length will diminish from infinity on the tangent to the actual radius of curvature when the engine is completely on the curve. Owing to this fact the centrifugal force will increase from zero to the full amount while the engine is entering the curve, as at any point when completely on the curve the normals must cross at the center of curvature. In this short time, however, the locomotive must have imparted to it

a certain velocity of rotation, and these will depend upon the speed of the engine, the radius of curvature and the length of the wheel base. In order now to figure out the actual amount of force for the conditions which we have assumed, we determine as explained above, that the velocity in feet per second, corresponding to 80 miles an hour, is 117. The weight of the engine in this case is 190,000 lbs., and the length for uniform weight approximately 30 ft., the center of gravity lying about 12 ft. back of the truck center. For an approximation we can consider that the moment of inertia around the center of gravity is equal to the weight multiplied by the square of the length and divided by 12, or

$$\text{moment of inertia} = I = \frac{190{,}000 \times 30^2}{12} = 14{,}250{,}000.$$

If we consider, however, rotation around the rear drivers, our moment of inertia will be increased by the product of 190,000 multiplied by 3 squared, or $190{,}000 \times 3^2 = 1{,}710{,}000$, and adding 14,250,000 we have 15,960,000 foot pounds as the total value of I when rotating around the rear drivers.

In Fig. 2 consider a weight W, on a rod without weight itself, hinged at the left, the weight being distant from the hinge an amount r, and a force P applied at a distance from the hinge l, acting in a horizontal plane. The effect of the weight at l can be found by $\frac{W r^2}{l^2}$, and we know that the acceleration is to 32.2 (g) as the force is to the weight, so that if a load placed a distance l from the hinge were acted upon by the force P, the acceleration would be $p = \frac{P g}{W_2}$, W_1 being the weight of the load. But for W_1 we may substitute $\frac{W r^2}{l^2}$ so that we obtain the equation $p = \frac{P g l^2}{W r^2}$

Now the angular acceleration $A = \frac{p}{l} = \frac{P g l}{W r^2}$, and as Wr^2 is the moment of inertia of the body W about the hinge and at a distance r from it, $Wr^2 = I$, so that $A = \frac{P g l}{I}$ and the torque, or rotating moment $= P l = A \times \frac{I}{g}$.

The angular acceleration A is obtained from the final angular velocity N and the time in seconds t during which the acceleration A produces the velocity N, thus: $N = A t$, and the angle traveled through in this time $= Q$ so that

$$Q = \frac{N t}{2} = \frac{A t^2}{2} \text{ and } A = \frac{2 Q}{t^2}.$$

When the engine enters the curve and the last driver passes the point of tangency, the engine has been rotated through the angle Q (as shown by the dotted location in Fig. 1), and for a 15-ft. wheel base and a radius of curvature of 2,865 ft., this angle $Q = \frac{7.5}{2865} = .0026$ radians, and as the velocity of the engine is 117 ft. per second, it requires a time $t = \frac{15}{117} = .128$ second to assume the angle Q. This means an angular acceleration of

$$A = \frac{2 Q}{t^2} = \frac{2 \times .0026}{.128 \times .128} = .32$$

And as the torque is P l we have this

$$P l = A \times \frac{I}{g} = .32 \times \frac{15{,}960{,}000}{32.2} = 159{,}600$$

foot pounds approximately. The center of front truck is about 15 ft. ahead of the rear driver so that this constitutes the lever arm and the force itself $= \frac{159\,600}{15} = 10{,}640$ lbs.

We see therefore that the normal horizontal force at the truck center necessary to give this engine such an angular acceleration that by the time the 15-ft. wheel base has completely entered the curve its angular velocity will be equal to the angular velocity of the body itself around the center of curvature, will be 10,640 lbs., and that this will be fairly constant during the time that the locomotive is entering the curve, this being based upon the assumption that the angular acceleration is uniform, which, however, is probably not strictly correct, but it will no doubt be near enough for our demonstration. The centrifugal force on the curve itself would be

$$.0000\,117 \times 6{,}400 \times 2 \times 190{,}000 = 28{,}454 \text{ lbs.},$$

or nearly three times as much, but it must be remembered that at the instant that the last driving wheel enters the curve the centrifugal force is at its maximum, and the force overcoming the angular acceleration is also in action, so that at this point we should no doubt have the greatest strain upon the truck, as in addition to the slewing effects spoken of above, and the centrifugal force, we should have the force due to the turning of the engine around a vertical axis. While passing through the curve the velocity of rotation would be constant as long as the speed on the curve was maintained uniformly, but on entering the following tangent the proceeding would be reversed, the centrifugal force would diminish from its maximum to zero, but at the instant when it began to diminish the full effects of the moment of inertia against rotation would appear.

We have assumed the case of 2 deg. curvature, and 80 miles an hour speed as it is generally customary to spiral curves that are sharper than 2 deg., therefore the effect of turning the engine in a horizontal plane would be less severe, but any case desired can be figured out in the manner above indicated by substituting the proper figures, and while we do not claim that this action had any responsibility in the case in question, and have no desire to associate it in any way with that accident, yet we believe that it will be of interest to engineers generally to compute in certain cases the effect of the moment of inertia of the engine in being rotated about a vertical axis when entering a curve.

Program of the American Railway Master Mechanics' Association, Atlantic City, June 12 to 14.

The sessions of the convention will be held, as was done last year, in the sun parlor near the ocean end of the steel pier. The Marlborough-Blenheim Hotel has been selected as headquarters. The President, Executive Committee and Secretary will have offices there. The enrollment committee will be located in the entrance to the steel pier. Each member of the Association, immediately upon arrival, should go to the enrollment booth, register and receive his membership button, if he has none, and be furnished a properly numbered celluloid disc showing his registration. Members will also be furnished with badges for their families. Cards for registration will be furnished at the enrollment booth at the entrance to the steel pier. Those members who expect to attend the M. C. B. convention should register twice, once for each convention, in order that a proper record may be kept of those present at each convention.

OPENING SESSION,
WEDNESDAY, JUNE 12, 1907,
9:30 a. m. to 1:30 p. m.

Prayer	9:30 a.m. to 9:35 a.m.
Address of President	9:35 a.m. to 9:45 a.m.
Intermission	9:45 a.m. to 9:55 a.m.
To allow those who desire to retire, although all are requested to remain.	
Action on Minutes of 1906 Convention	9:55 a.m. to 10:00 a.m.
Reports of Secretary and Treasurer	10:00 a.m. to 10:15 a.m.
Assessment and announcement of dues; appointment of committees on Correspondence, Resolutions, Nominations, Obituaries, etc.	10:15 a.m. to 10:25 a.m.
Election of Auditing Committee	10:25 a.m. to 10:30 a.m.
Unfinished business	10:30 a.m. to 10:35 a.m.
New business	10:35 a.m. to 10:45 a.m.
Discussion of Reports on:	
Mechanical Stokers	10:45 a.m. to 11:00 a.m.
Shrinkage Allowance for Tires	11:00 a.m. to 11:30 a.m.
Locomotive Lubrication	11:30 a.m. to 12:00 m.
Topical Discussion:	
Apprenticeship System on the New York Central Lines. To be opened by Mr. C. W. Cross	12:00 m. to 1:00 p.m.
Discussion of: Individual Paper on Shop Cost Systems. By Mr. A. Lovell.	1:00 p.m. to 1:30 p.m.

Adjournment.

MIDDLE SESSION.
THURSDAY, JUNE 13, 1907,
9:30 a.m. to 1:30 p.m.

Discussion of Reports on:	
Results of Use of Different Valve Gears	9:30 a.m. to 10:30 a.m.
Proper Spacing of Flues in High-Pressure Boilers	10:30 a.m. to 11:00 a.m.
Blanks for Reporting Work on Engines Undergoing Repairs	11:00 a.m. to 11:15 a.m.
Development of Motor Cars for Light Passenger Service	11:15 a.m. to 11:30 a.m.
Proper Width of Track on Curves, to Secure Best Results with Engines of Different Lengths of Rigid Wheel Base	11:30 a.m. to 12:00 m.
Topical Discussions:	
1. Is it desirable to eliminate water-gage glasses on locomotives to enforce the use of gage-cocks? To be opened by Mr. F. F. Gaines	12:00 m. to 12:30 p.m.
2. Relative merits of outside and inside delivery pipes in connecting with locomotive injectors. To be opened by Mr. Strickland L. Kneass	12:30 p.m. to 1:00 p.m.
Individual paper on Cause of Leaky Flues. By Mr. M. E. Wells.	1:00 p.m. to 1:30 p.m.

Adjournment.

CLOSING SESSION.
FRIDAY, JUNE 14, 1907,
9:30 a.m. to 1:30 p.m.

Discussion of Reports on:	
Superheating	9:30 a.m. to 10:30 a.m.
History of Movement of Locomotives at Terminals	10:30 a.m. to 10:45 a.m.
Individual paper on Locomotive Failures. By Mr. W. E. Dunham	10:45 a.m. to 11:15 a.m.
Subjects	11:15 a.m. to 11:30 a.m.
Unfinished business:	
Reports of Committee on Resolutions, Correspondence, etc.	11:30 a.m. to 12:00 m.
Topical Discussion:	
1. The corrugated tube for locomotive service, with the view of bringing out the reasons and advantages for its use. To be opened by Mr. George West	12:00 m. to 12:30 p.m.
2. What is the best metal for hub liners for driving and engine truck wheels, the best method of applying and limiting lateral hub play for such wheels before repairs are required? To be opened by Mr. J. F. Dunn	12:30 p.m. to 1:00 p.m.
Election of officers / Closing exercises	1:00 p.m. to 1:30 p.m.

Adjournment.

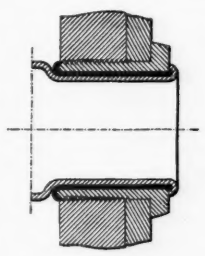
New Zealand Railroads.

The question whether state railroads are to be worked as commercial undertakings, so as to produce a surplus over and above working expenses and interest, or so as to give the greatest possible service to the public at the lowest possible charge consistent with payment of expenses and interest, is raised by the Commissioner of Railways for Western Australia in his latest report. New Zealand has long acted on the second alternative, but the Australian administrations have not been so definite. So far as western Australia is concerned, the management of the railroads appears to have been placed under the control of the commissioner, subject to certain matters requiring ministerial approval. Comparisons have been put forward and statements publicly made which show that the goal aimed at by the state was to secure the utmost direct profit possible from the railroads. Yet, when the indisputable results have come forth, an agitation for reduction of rates has at once cropped up. With regard to the timber industry this has been successful, and the commissioner estimates that the current year's revenue must lose some $79,000. If the working railroads have to pay more for both coal and water than the fair price, to reduce freight rates considerably, to pay an ever-increasing interest bill, and to construct non-paying spur lines for the development of agriculture, the commissioner considers it evident that a surplus cannot long be maintained, and that if the country really wants the second alternative the parliaments should definitely say so.

Tests of Very Mild Steel Tube Sheets.

According to the *Organ der Fortschritte des Eisenbahnwesens* the repair shops of the Prussian railroads for the line running from Cologne to Nippes, have recently made a test of some steel tube sheets under the following conditions:

The feedwater that is used in engines which are repaired at these shops is very bad, with the result that after a short term of service, cracks are apt to appear in the red copper tube sheets, so that they are soon unfit for service. The cracks begin on the fire side and gradually increase in depth until they extend through the sheet. The cracks always run on a line with the second vertical row of tubes, and on each side of the sheet, and work across the five first bridges between the tubes. They then extend over them all until the sheet is rendered useless. It has been noted for several years that the method of building the boiler had little or no influence upon the production of these bridge cracks. It can, however, be said that the flexible or expanding staybolts and the use of short wood fireboxes has slightly improved the situation. The principal elements influencing the matter on the other hand are: The steam pressure and the nature of the scale. As the pressure is increased, and with it the temperature of the copper, the plate is weakened in its tensile strength accordingly. In the matter of scale, its influence depends upon its permeability. The waters in the neighborhood of Cologne are charged with magnesium salts, and the locomotives carrying a pressure of 170 lbs. to the sq. in. begin to show cracks in 10 or 12 months, and those carrying 200 lbs. pressure in from four to six months, while others working in a territory where the water is better will run from two to three years without developing any cracks in their tube sheets. The reduction in the number of tubes in the upper corners of the sheets for the purpose of increasing the size of the bridge does not seem to have any influence. The means taken to increase the life of the sheet is by the insertion of a screwed bushing, as shown in the engraving. The number of each is limited to 40, and when more than this is required the sheet is changed. As will be seen from the engraving, this method of repairing consists in applying a copper washer about ⅜ in. thick to the fire side of the sheet, and holding it in place by a screwed bushing of very mild steel, into the inside of which the tube is expanded, and as every kind of hammering is positively forbidden it will be seen that the adjustments will have to be made very carefully in order to secure tightness. This is the only method of repairing that is proven effective up to the present time. In this way the life of the sheet can be prolonged from two to three years. When it is necessary to change the sheet, it takes from four to six weeks work at the Lippes shop.



Detail of Copper Ferrule.

This rapid destruction of the tube sheets has naturally led to investigations in order to obtain a metal offering greater resistance than copper. In these attempts, copper, zinc, iron, silicon bronze and aluminum bronze made by Eckman & Duisbourg have been tried, but all these attempts have resulted in failure.

On the other hand, trials that were made in 1894 and 1896, with fireboxes made of very mild steel, showed that the steel in direct contact with the incandescent coal changed so rapidly that after only three or four months it was necessary to replace the firebox, although the whole zone that was not in direct contact with the coal was still in very good condition. A chemical study of the steel that had thus been changed showed that it was due to a rapid carbonization of the metal in direct contact with the coal. Thus in a sheet $^{5}/_{16}$ in. thick the percentage of contained carbon rose to .13 per cent. instead of .01, which it originally had. True cementation, therefore, had taken place, as confirmed by the tensile and bending test. The conclusion of this inquiry was, then, that it was necessary to continue to make those parts of copper that were in direct contact with the coal, while those that were in contact with the gases could be made of steel. On account of the unusual form which it would thus be necessary to give to the firebox, it was decided not to resort to this last expedient until every other method had been exhausted. Not until 1900 was an eight coupled engine fitted with a new tube sheet that was to be subjected to a pressure of 170 lbs. The firebox had never run more than two years. This sheet was run for more than three years in spite of the bad quality of the feedwater, and without showing the slightest signs of deterioration. At the end of three years the sheet was subjected to an exceedingly careful inspection, and it was found to be free from defects. Furthermore, during these three years far less trouble had been experienced with the tubes than

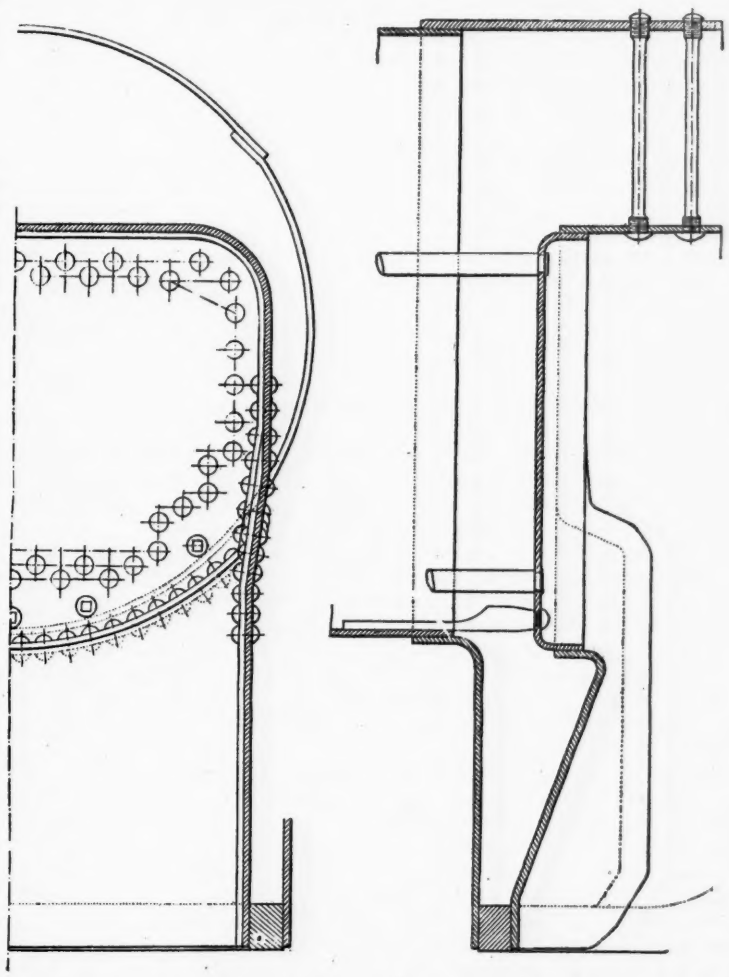


Fig. 2—Composite Copper and Steel Tube Sheet; Prussian State Railways.

with the ordinary copper sheet. The maximum elongation of the tube holes amounted to .06 in. As a result of this trial, the same system of construction was applied to a six-coupled engine, carrying 200 lbs. pressure. The new copper sheet, which had been put in this engine in June, 1901, had developed cracks in the month of November of the same year. It was repaired by means of the screwed bushings, but the sheet had to be replaced in January, 1904. The locomotive left the shops in May, 1904, with a composite copper and iron sheet, and was put into service on the line between Cologne and Treves in heavy traffic. This sheet has in the meantime, that is, during the period of about two years, remained in a perfect condition, and has thus shown that this system of construction meets all the requirements of the heaviest service.

The engraving given herewith shows the design of the new sheet. It presents no difficulties in the boiler shop, simply requiring that care be employed in putting it together, and that attention be turned to the point where it is attached to the steel tube sheet; to the side sheets of the firebox, and to the copper portion of the tube sheet, which is doubled, and thus brings four thicknesses together. Naturally, with this system, a construction as

applied to a new boiler is so arranged as to do away with the sharp angles.

It is also to be noted that the tubes are expanded into copper ferrules of .06 in. thickness, set in the sheet as is common practice with steel tube sheets. The copper portion of the tube sheet is held by copper staybolts, and not of iron, for experience has shown that the heads of iron staybolts will sink down into the copper.

Liability for Injuries to Live Stock.

BY JOHN EDSON BRADY.

The responsibility in damages of a railroad company for injuries to live stock, which manage to get upon the company's right of way and in the path of its trains, varies greatly according to the jurisdiction in which the question comes up. Practically every state has upon its statute books enactments intended for the government of the liability of railroads in such cases and, though the same statutory provision is occasionally found to exist in several states in substantially the same form, but very few states are found to have the same general combination of statutes regulating the matter. To this cause may be partially attributed the wide diversity of rules of legal liability found in the different states.

The one general proposition which is supported by the decisions of all states is that there must be negligence on the part of the railroad company in order to warrant a recovery of damages for animals killed or injured by the company's trains. But this general harmony is of slight extent, for there is no similarity among the various jurisdictions as to what may or may not constitute negligence. For instance, there are statutes in many states which declare that a railroad company shall be presumed to have been negligent upon a showing that an animal has been run into and injured while on the tracks of the company. These statutes make out a *prima facie* case of liability against the railroad and place upon the company the burden of overcoming the presumption of negligence. The introduction of sufficient proof to establish the company's freedom from negligence will, of course, always act as a rebuttal of the statutory presumption. Thus, in an action to recover damages for the killing of two horses by the defendant's train, testimony in the company's behalf that the animals were killed by a passenger train in the night time, when the train was running at a rate of sixty miles an hour or more, and that, under the circumstances, it was impossible to stop the train in time to avoid injury, although it was thoroughly equipped with proper appliances, is sufficient to overcome the *prima facie* case of negligence made under the statute. (Felter vs. Anderson [Kentucky], 66 S. W. Rep. 182.)

The legislatures of a number of states have, at different times, enacted laws under which the owner of live stock was permitted to hold a railroad company absolutely liable for damage to his stock by the company's locomotives or cars, without any regard to the actual negligence of the company's agents and irrespective of whether the company had complied with its statutory duty to fence its right of way or whether such a duty was in fact imposed. But, fortunately, such statutes have been uniformly declared unconstitutional on the ground that their enforcement would amount to a taking of the property of railroads without due process of law. A fair example of the class of statutes referred to is one which became a law of the state of Alabama in 1877 and provided, "That from and after the passage of this act, all corporations, person or persons, owning or controlling any railroad in this state, shall be liable for all damages to live stock, or cattle of any kind, caused by locomotives or railroad cars." Under such a statute, no matter what prudence and skill those having charge of a train might employ, the railroad company would be liable for any damage to live stock without opportunity or right to defend. It would be necessary to establish two facts only in order to authorize a recovery of damages from the railroad company, viz.: ownership of the animals and injury by the locomotives or cars of the company. In declaring the Alabama statute, quoted above, unconstitutional, in the case of Ziegler vs. S. & N. Alabama Railroad Company, 58 Ala. 599, the Supreme Court of that state said: "We have said above that the statute under discussion dispenses with all proof of the most material element of the wrong it seeks to redress. It declares that the railroad corporation shall make reparation for an injury inflicted in the authorized prosecution of its lawful business, without a semblance of fault, negligence or want of skill in its employees; an injury, which no human prudence or foresight could prevent; and yet, the statute will not allow the railroad to exculpate itself, by proof of the highest qualifications and the most watchful vigilance. This falls short of due process of law. We have heretofore declared a rule which exacts from railroad corporations a high degree of skill and diligence, to prevent injuries to persons and property. We have no wish to modify that rule. But when these very useful corporations conform to this strict rule of diligence, we can perceive no reason, in law or morals, for holding them to a stricter measure of accountability for inevitable misfortunes, than would be exacted from natural persons for injuries which result from unavoidable accident, or accidents which no human prudence can foresee or avert." Statutes, similar in character to the Alabama provision, have been declared unconstitutional in Colorado, Florida, Idaho, Montana, Nebraska and Utah.

The legislatures of several states, including Illinois, Indiana, Kansas, Missouri, Montana, Tennessee, Utah, Vermont, Wisconsin and Colorado, have adopted a statute which imposes upon railroad companies the duty of erecting and maintaining fences and declares them to be liable for any injury to live stock in event of a default in the performance of the duty to fence. The statute in this form, while undeniably less harsh than the Alabama statute mentioned above, nevertheless holds the railroad corporations to a fairly strict liability. These statutes have generally been stamped with the approval of the courts when the question of their constitutionality has been raised.

The Missouri statute, rendering railroads liable for double the amount of damage to animals occasioned by the failure of the company to construct or maintain fences and cattle guards, was passed upon by the Supreme Court of the United States in the case of Missouri Pacific Railway Co. vs. Humes (115 U. S. 512), wherein an action was brought to recover double damages, provided for in the statute, for the loss of a mule valued at $135. The defense was that the statute was void in that it violated the constitution of the United States as well as that of the state of Missouri, amounting to a deprivation of property without due process of law. But the statute successfully stood the scrutiny of the learned tribunal before which it came for examination and was held to disclose no constitutional defects. "The omission to erect and maintain such fences and cattle guards in the face of the law," said Mr. Justice Field, who delivered the opinion of the court, "would justly be deemed gross negligence, and, if, in such cases, where injuries to property are committed, something beyond compensatory damages may be awarded to the owner by way of punishment, the legislature may fix the amount or prescribe the limit within which the jury may exercise their discretion. The additional damages being by way of punishment, it is clear that the amount may be thus fixed; and it is not a valid objection that the sufferer instead of the state receives them. This is a matter on which the company has nothing to say. And there can be no rational ground for contending that the statute deprives it of property without due process of law."

In an action to recover damages from a railroad company upon a cause of action such as is within the contemplation of this article, a defense which is interposed more frequently than any other is that of the contributory negligence of the owner of the injured property. For the purpose of taking up the efficiency of this defense under various circumstances it is necessary to divide the cases into two classes, namely: (1) cases in which the railroad was properly fenced at the point where the injury occurred or in which no duty to fence was imposed by statute; (2) cases in which the company failed to fulfil a statutory duty to fence. In cases belonging to the first of the two mentioned classes, that is where the question of liability may be determined independently of any statutory obligation to erect and maintain fences, the ordinary rules of contributory negligence apply and where it is shown that the negligence of the owner of the animals contributed to the cause of the injury there can be no recovery against the railroad. The chief difficulty lies in reaching a satisfactory conclusion as to whether a certain set of facts show the presence of contributory negligence. Driving cattle across the tracks of a railroad without taking the precaution to look and listen before doing so has been held to constitute contributory negligence. (McGill vs. Minnesota, etc., Railroad Co., 85 N. W. Rep. 620.) And it has been decided that a recovery of damages is barred by proof that the plaintiff walked behind a wagon, to the rear of which two cows were tied, when approaching a crossing, instead of remaining on the seat of the wagon in control of the horses. (Snell vs. Minnesota, etc., Railroad Co., 91 N. W. Rep. 1108.) But allowing animals to enter and remain upon the unenclosed lands of another is not contributory negligence (Texas, etc., Railway Co. vs. Seay, 69 S. W. Rep. 177), nor is the leaving open of a pasture gate, with the knowledge that a cattle guard at a nearby crossing is defective. (Herrell vs. Chicago, etc., Railroad Co., 90 N. W. Rep. 1071.)

As to whether it is contributory negligence to allow stock to run at large, the authorities are at variance. In the absence of any statute making it unlawful to allow cattle to run at large and of any legal requirement as to the erection of debarments it is held that the owner of cattle is guilty of contributory negligence if he allows them to become trespassers upon the right of way of a railroad company in Indiana, Maryland, Michigan, Minnesota, New York, New Jersey, Pennsylvania and Rhode Island. On the other hand, in Alabama, California, Florida, Illinois, Iowa, Kansas, North Carolina, Ohio, Texas and other states it is not contributory negligence to allow stock to be at large. But where animals are unlawfully at large, for instance, where the owner allows them to run at large in a town or elsewhere when their being at large is prohibited by statute, such violation of the law constitutes contributory negligence and, under these circumstances, a recovery of damages

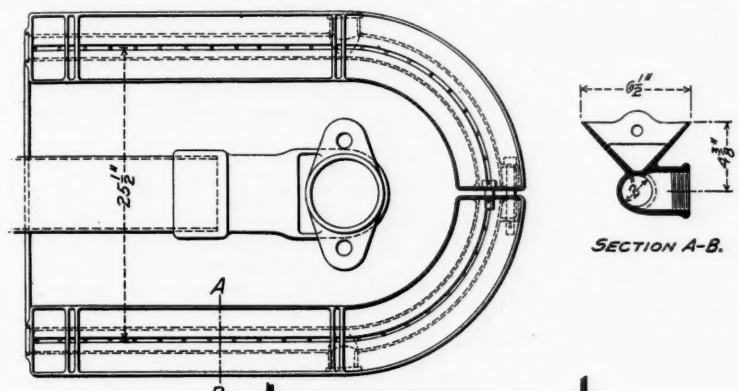
cannot be had. The authorities are practically unanimous on this point. However, it has been held that this rule does not apply when the animals are at large through no fault on the part of the owner. (Toledo, etc., Railroad Co. vs. Johnston, 74 Ill. 83.)

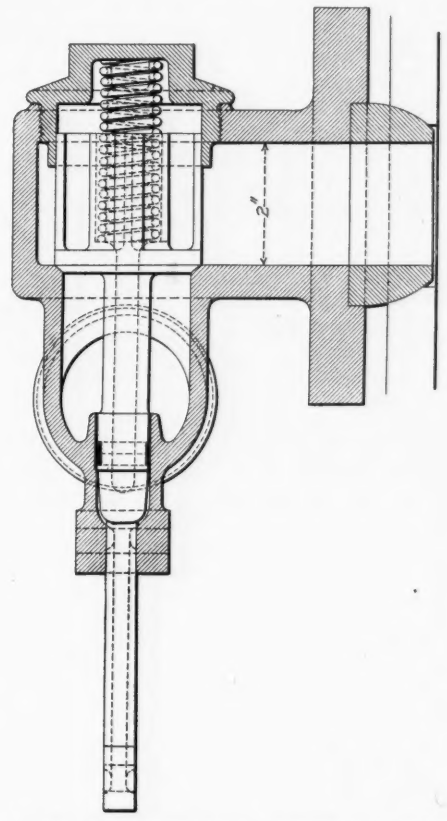
In cases belonging to the second of the two classes mentioned above, that is where the railroad company's failure to maintain proper fences under a statute is a factor, the decisions are again irreconcilable. The statutes of California and Oregon provide that in actions for injuries to animals, grounded upon laws requiring railroads to fence, the plaintiff's contributory negligence bars a recovery, while in Iowa it is expressly declared by statute that contributory negligence in such a case is no defense. The other jurisdictions are about evenly divided upon the question of whether an owner of animals injured by trains, who is shown to have been contributorily negligent, is entitled to recover damages from the railroad company.

The Barnes Skimmer and Blow-Off Valve.

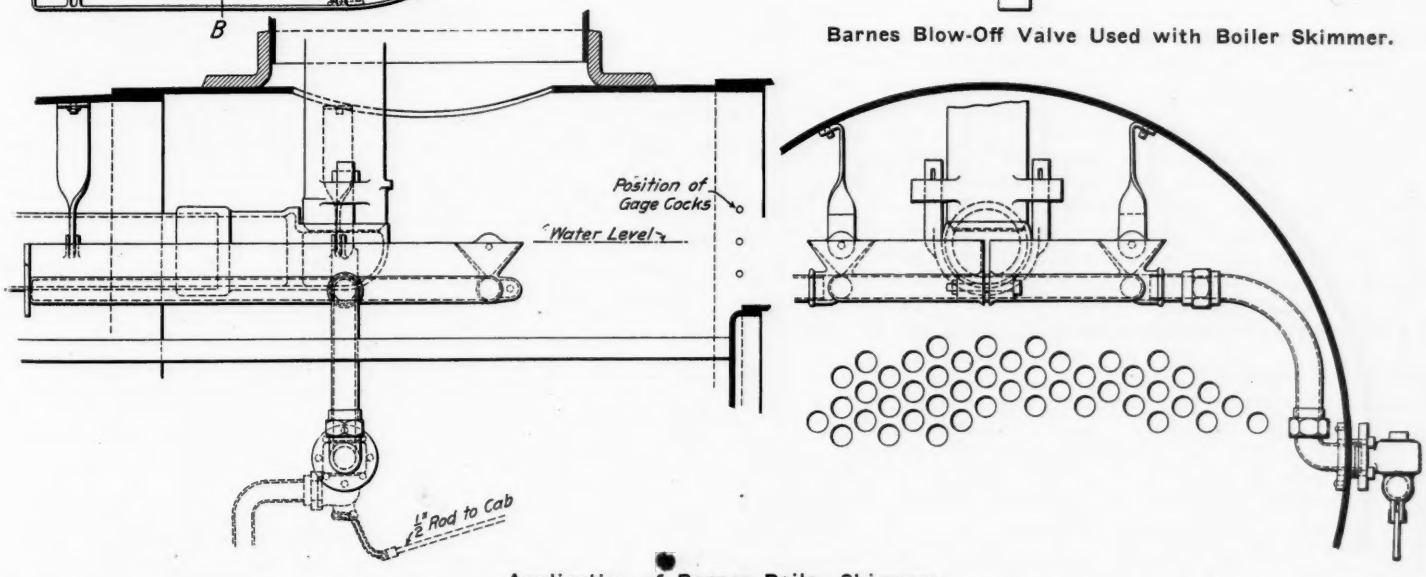
Somewhat more than a hundred locomotives on the Wabash Railway are equipped with a skimmer and blow-off valve designed by the Superintendent of the locomotive and car departments, J. B. Barnes. The idea of using a skimmer for the removal of the sludge that rises to the surface of a boiler using water impregnated with carbonates of the calcium and magnesium compounds, is old in stationary practice. It is also successfully used where non-incrusting solids that are the compounds of the alkalies are present, and which, when present in excessive quantities cause foaming. It is believed by some that "boiler-foaming takes place only in the presence of particles of matter suspended in the water." Skimming, therefore, serves to collect such particles as may come to the surface and remove them through the blow-off. It is, in fact, a surface blow-off that draws from a wider extent than a simple pipe could be made to do.

Attempts have been made, from time to time, to apply the skimmer to the locomotive, but its inaccessibility, the jars to which





Barnes Blow-Off Valve Used with Boiler Skimmer.



Application of Barnes Boiler Skimmer.

it is subjected and the great difficulty of cleaning has made all former attempts at its application unsuccessful.

The Barnes skimmer that is used on the Wabash is exceedingly simple in construction and reports indicate that it is successful in operation. It consists of a pan U-shaped in plan extending down each side of the shell and with the legs coming together back of the throttle valve. In cross section it is V-shaped, ending in what is practically a 2-in. pipe, that has a large number of $^5/_{16}$-in. cored holes at the top and running into the bottom of the V. This is 6½ in. wide at the top and 4⅜ in. high, and is set with the top edge flush with the center of the middle water gage. The whole is formed of two castings that are bolted together at the center back of the throttle. It is carried by four hangers held to the shell by studs.

A 2-in. outlet is placed upon each side and connected with a blow-off valve, also designed by Mr. Barnes. This valve is of brass with the exception of the lever, which may be of either malleable iron or cast-steel. The valve itself is cast solid with the stem, the part above the seat having four wings which fit into a projection of the cap nut, that forms a guide, which with the stem passing through the valve body insures the proper seating of the valve. A spring above the valve makes it impossible for the valve to remain open when the lever is released. The passages are of large size and with a valve lift of ½ in. there is an ample allowance for a free outrush of water that will carry any sludge floating near the skimmer out with it.

The blow-off valve is manipulated by a rod extending back to the cab, where it is within easy reach of the engineer or fireman. The waters used, where this skimmer has been put in use, are impregnated with the carbonates and sulphates of lime and magnesia, with some chloride of sodium or common salt; just the combination to produce a sludge and foaming. It was first put upon an Atlantic engine with a 64¼-in. boiler in passenger service, and in a record of about a month from Oct. 26 to Nov. 23, 1906, it ran 1,000 miles without the skimmer and was washed out eight times; it then ran 8,173 miles with the skimmer and was washed once, thus effecting a saving of seven washings with a gain of 7,173 miles of service. As it costs $1.50 to wash a boiler, the saving in this item alone was $10.50. It is also estimated that about 1,000 lbs. of fuel are consumed for each washing which would have cost $4.80 more. Then there is the rental value of the engine which is placed at

$15 a day, so that on the whole it appears that in one month the skimmer saved $15.30 in cash and something more than $30 in estimated rentals, which was considered a good dividend on the cost of application, $35.

At the end of the time for which the record was taken it was found that there was 1½ in. of mud in the bottom of the boiler and 8 in. in the leg of the firebox, with the crownsheet in first class condition.

The Hedjaz Railroad.

In 1900 the Turkish government began the building of a railroad from Damascus to the holy city of Mecca. Its total length will be about 1,120 miles, of which 440 had been built by the end of 1906, and the remaining 680 will be completed in course of time. Officially it is known as the Hedjaz Railroad, taking its name from that of the Arabian province through which it passes. For its construction no loans, foreign or domestic, have been raised. The labor for the grading is furnished by the army and the money necessary for bridge and masonry construction, superstructure, rolling stock and station building is obtained from the pious contributions of the faithful. It is an indication of the hold of the religion of Mohammed on the people, that these contributions are regularly bringing in $1,555,000 annually, and each year the road advances 60 to 100 miles. Not only does religious enthusiasm furnish funds and animate the troops employed, but it even deters the Bedouin from interfering with the work.

The road has a general southerly direction, and 300 miles south of Damascus enters the arid region. Here the difficulties of construction increase as the road advances due to the scarcity of water and the necessity of transporting everything required by man or beast either by train or caravan. These conditions continue till Medina is reached, 840 miles south of Damascus. The route follows quite closely that of the great Pilgrim road to Mecca. Indeed, the important points of the territory to be traversed were originally determined by engineers traveling as pilgrims with the holy caravan. The plan of operations is for a reconnaisance party to map out the country 90 miles ahead of the end of the road. This is followed by a locating party, whose notes are forwarded to a technical bureau with headquarters at the last large station of the already completed road, where the details of construction are worked out.

The distribution of the working parties is as follows: Three battalions of infantry, 3,000 men, are utilized for grading (earth and rock work), each man receiving an addition of 5 to 15 cents to his ordinary army pay. Contractors, mostly Italians or Austrians, construct the culverts, bridges, tunnels, buildings, etc., at stations, in short, carry out all work requiring mechanical ability. Two railroad battalions put in place a bedding of broken stone, place ties and lay rails. A company of pioneers brings up the rear, whose duty it is to finish up the roadway. For the telegraph line part of a telegraph company is detailed.

The gage of the track is 3 ft. 5½ in. At first wooden ties were used, but proving unsatisfactory in the dry and hot climate, their use was abandoned in favor of iron ties. Rails weigh 43½ lbs. and the superstructure (ties, rails and fittings) average 218 lbs. per running yard. The rolling stock consists of 43 locomotives, 522 freight and 31 passenger cars. Ordinarily it is nearly all employed for construction purposes, but at the time of the Great Pilgrimage to Mecca, it is all devoted to the transportation of pilgrims. At that season five large pilgrim trains leave daily, the large quantity of water, provisions, riding and pack animals required for the journey to Mecca having been accumulated in advance at the point of departure of the caravan.

The railroad employees, engine runners, firemen, station men and section hands are mostly natives, and they are not very satisfactory.

The engineer at the head of the enterprise is Meissner Pascha, a German officer who has had large experience in connection with railroad work in Turkey. While at first a large number of foreign engineers were employed, these have gradually been replaced by Turkish officers and young Turkish engineers who have been trained at technical schools, so that at the present time they form the greater part of the engineering staff.—*Zeit. d. v. Deutscher Eisenbahnverw'ng.*

Railroad Fire Extinguishers in Massachusetts.

The Massachusetts Railroad Commission recently examined various devices for extinguishing fires which had been presented for approval, according to law, by the railroads—There were five different types of apparatus. The New York, New Haven & Hartford, the Hoosac Tunnel & Wilmington and the Central Vermont presented liquid extinguishers; the Boston & Maine and the Boston & Albany, dry powder extinguishers. The types presented by the New Haven and the Hoosac Tunnel & Wilmington were approved, but that of the Central Vermont was not approved. In order to make a comparison between the dry and liquid types of extinguishers, the Boston & Maine and the Boston & Albany were ordered each to equip 100 cars with some form of liquid fire extinguishing apparatus, using dry extinguishers on other cars. The liquid apparatus prescribed by the board must have a capacity of at least three gallons. The different companies are to report at the end of a year the results of their experiences with the different extinguishers.

The Value of Good English to the Engineer.*

Technical men are peculiarly prone to offend in the use of their mother tongue, because they have not, as a rule, read deeply in classical literature or been instructed thoroughly in the construction of the language. Their higher education is generally almost entirely technical. Yet the character of the technical man's language is important in his social and business intercourse; in his business and professional correspondence; in the promulgation of orders, rules and regulations for the guidance of those under his direction; in the preparation of specifications, contracts and reports; in writing and delivering addresses and technical papers; and in writing technical books for the advancement of his profession. A technical man is, presumably, an educated man, and if he does not speak and write like one, suspicion is cast upon the entire range of his learning. When a man cannot spell correctly, or use ordinarily good grammar, it is difficult to convince others that he is professionally able. There are many vocations in which it is not essential that a man be cultured and intelligent; but the technical professions are not among them. Nothing so surely marks a man's secret habits of thought, his real character, as the little tricks of speech which are exhibited when his mind is on the matter rather than the manner of his speech.

In business correspondence the value of good usage is still more manifest than in conversation, since the written word is permanent, and correspondence greatly extends the field of one's intercourse. A letter often passes through many hands and multiplies the good or bad impressions it produces. If its import is not clear, it may cause disagreement or involve serious financial disadvantage. Even bad punctuation will often seriously alter the entire meaning of a sentence, and bad grammar in particular at once stamps a writer as being something of an ignoramus. The art of letter writing, like a knowledge of grammar, is commonly considered to be within the range of everyone; but anyone who has had large experience in business correspondence knows that few men write good letters. It is so rare to find a matter which is composed of more than one or two items, clearly, concisely and thoroughly discussed in a letter that favorable attention is immediately attracted to its writer. Not a few men owe the opportunity for advancement to their ability to write a good letter.

The detrimental results of bad English in conversation or in correspondence are by no means as great as in formal technical articles. Every normal, healthy-minded technical man desires to leave a permanent record of the results of his best thought and work to aid his co-workers and those that come after him. An ably written description of work performed, discoveries made, or methods developed accomplishes more for the advancement of science than many well designed and well executed works. In the preparation of articles for the technical press, and papers for the learned societies, there is time to study form and style and to eliminate errors due to haste; hence, when such matters are ill written, it is not unfairly argued that the writer is ignorant of the correct use of the language. Such an opinion is exceedingly detrimental to the writer. It weakens his arguments, causes him to be misunderstood, or so detracts from the interest of his readers that the matter is not read. The idea that a technical paper is dry at best, and that the English employed in it is of small consequence has long been proved incorrect. Certain of the better magazines print only carefully selected matter and reject everything but scholarly, well written articles. Their influence upon the language is quite as good as that of the better books of the day; but the well written article costs more money than the "pot-boiler," hence, the magazine is more expensive, its circulation is limited, and it influences a smaller number of readers than its cheap and less worthy competitor. Yet there is so much nowadays that is well written that no busy professional man is willing to spare the extra time and effort necessary to read and digest an ill written paper.

The style should be crisp and clear. An elegant, showy style is often a sign of lack of breeding. Short words of English origin are invariably stronger and more rugged than their longer and more elegant synonyms which are derived from the Latin or Greek; hence their use is nearly always to be preferred. Simplicity and force demand simple, direct language. The style should be so smooth and so unostentatious that the hearer's attention is not drawn to the language, but is left entirely free to follow the course of the thought.

*By John Lyle Harrington, Consulting Engineer. Abstract of a recent address to the Technological Society of Kansas City, the Engineering Society of the University of Missouri, and the Civil Engineering Society of the University of Kansas.

Track Deformations and Their Prevention.*†

BY G. CUENOT,
Government Engineer of Bridges and Highways, and connected with the Board of Control of the Paris, Lyons & Mediterranean Railway.

XIII.

RECAPITULATION AND CONCLUSIONS.

In the first part of this study, I pointed out the principal deformations which track can undergo and which consist of: Creeping, the reduction of gage on tangents, or spreading of gage on curves, the compression of the tie at the supports, the tearing out of the screw spikes, the poor holding of the joint, which produces dislocation of the track and the vertical deformation of the rail.

I have shown that all these deformations, which when taken singly, have only a small influence, exercise, in the aggregate, a considerable effect, as much from the point of view of limiting traffic as from facility of maintenance, and that they prevent the increase of speed on all sections of lines where that increase is desirable. Two principal causes act to produce these deformations: the bending of the cross-tie and the longitudinal movement of the track.

Some eminent engineers, Mr. Coüard notably, who has been the most careful and patient observer, have only imperfectly seen this relation of cause and effect; Mr. Coüard concluded, after having summarized these observations in a series of articles in the *Revue des Chemins de Fer*, that there was occasion for increasing the moment of resistance of the tie, and substituting for the type actually in use a type with reinforced section much more rigid. This conclusion, set forth in 1897, was a logical one; it contradicted in some respects the interpretations of a group of engineers, notably represented by the Germans, who thought that the loaded cross-tie rested completely on its bed of ballast, and that consequently the pressure was transmitted integrally over this bed, here more, there less, according to the sinking of the ballast or the deformation of the cross-tie. I believe that I have shown experimentally the error in this theory. The non-loaded cross-tie placed under the best conditions of stability rests on its extremities; under the effect of the load, it is deformed and is moulded in the ballast. The ballast subsides little by little, and finally takes the form of the deformed cross-tie. The subsoil reacts more or less according to its nature, and that is what gives to it the illusion of that elasticity, which has been freely ascribed to the ballast.

But the cross-tie does not transmit to all points of its bed the pressure arising from the load which is applied to it. The zone of influence of the load is very limited, scarcely 13.78 in. to 15.75 in., from its point of application. This follows a general law, already partly defined, notably by Mr. Mesnager, Engineer of Bridges and Highways, in charge of the laboratory of the school, who has demonstrated that, in pugging, in connection with beams, the entire length of the pugging should not enter into the computation so as to reduce the section of the beam, as the zone of influence of the load is limited. It follows that on a movable bed, as that which is made up of the roadbed and the ballast, the application of the load is made over a very small length on each side of the rail; beyond that, not only is there no pressure, but a tendency to a sub-pressure. It is similar to that produced with a substance of small resistance, like turf, where the load causes the soil around the loaded and displaced zone to rise up. Here the phenomenon is clear, but in the case of track it is more hidden.

It is not then necessary to extend a cross-tie beyond a certain limit, and that limit corresponds precisely with the length which gives the minimum deformation of the piece. With that length the maximum of useful effect and the uniform distribution of the load on the ballast will be obtained. This is an appreciable result. If the tamped bed be maintained as originally established, there will be no more such frequent unwedging.

The question of the length to be given to tamping will be solved at the same time. It has not been up to the present time, because the problem, as was stated, did not admit of solution. It has been sought to discover what is the length to be given to the tamped bed under a cross-tie of whatever length, having no relation, on the one hand, with the load, and, on the other, with the gage of the rails. All the solutions were equally good, or rather bad. The problem is indeterminate, because it does not admit of a single solution. It is necessary, as I have pointed out, to reverse the position of the problem and seek the length to be given to the cross-tie, in order that it shall experience the minimum of flexure. The limit to be given to the tamped bed corresponded with this minimum of flexure.

Neither has sufficient attention been paid to the manner in which the tamping should be done; some trackmen do it on the right, while others do it on the left. There is no uniformity in their efforts, and the unequally tamped tie has a natural tendency to become unwedged. Mechanical tamping, which Mr. Albert Collet has rendered practicable, will give, we believe, excellent results, and its general use will be imposed, when it is desired to establish a very stable track always comparable with itself.

But this stability of the track will not yet be complete, if the joints are not redesigned, if we do not fix them firmly and avoid dislocation, which the best and most solid splicing only retards. All that has been attempted up to the present time is to render this splicing more rigid and to bridge it, so to speak, between the two cross-ties of the even joint. Some engineers have been logical; they have drawn the cross-ties of the even joint nearer together, and they have joined them as twins, but few have dared to go to the end, that is to say, to place the cross-tie under the joint in order to support it. They were afraid, doubtless, that they would be reproached for sacrificing elasticity, the vague term which comprehends everything, and for creating hard points. It is the contrary which is true; the hard point is found between two ties. Elasticity is given by the tie, by the sinking in the ballast and the roadbed. It is necessary then to approach the problem resolutely, as established by experience. It is necessary to support the joint by a rigid cross-tie, which will diminish the bending, and consequently the longitudinal movement, the cause of the dislocation of the splicing. It is necessary to draw together the two neighboring cross-ties, to reduce their separation from the joint cross-tie, to prevent the rocking movement which is necessarily produced by too great a spacing.

It remains to select the type of cross-tie corresponding to the general conditions which we have imposed. A rigid cross-tie is necessary, much more rigid than the actual wood cross-tie, which has a resisting moment of about 36, wherever it is desired to increase the speed. This necessity for reinforcing the cross-tie excludes, *ipso facto*, the steel cross-tie in the form of a trough, because its resisting moment can only be increased by adding to the thickness of the metal or to its depth. In the first case, a cross-tie too heavy would be beyond price; in the second case, being too deep, it would no longer be capable of being tamped.

It is possible, then, only to take the wood cross-tie with a stronger section, or else a composite cross-tie (wood and iron, cement and iron, etc.) of a type similar to that which has been experimented with. We can find fault with the high price of the skeleton of the latter, which, being constructed with a special iron, will be expensive to manufacture. The inventors have themselves stated this disadvantage. Mr. H. Michel invented a new model of cross-tie as rigid as the first, but of a more practicable application, because it is composed of commercial shapes of iron at the current price, and because it allows of the design of different types, according to the resistance which it is proposed to obtain. It is easily possible to adopt it in secondary tracks, and obtain a cross-tie whose stability is better and durability longer, without sensible increase in the cost price.

This cross-tie is composed of two pieces of channel iron, or T iron, held together by clamps, between which the wood blocks, which are required for fastenings and as a means for distributing the pressure on the ballast, are squeezed. It presents the same advantages as the experimental cross-tie, and has, besides, the following: easy tamping, exposure of the blocks, readjusted if desired with shims, easy renewal of the pieces. The compression of the elements (wood and iron) is greater than in the first system, because of the tension given to the clamps and to the compression of the wood. It is a beam of armored wood.

In resistance, this new type of cross-tie presents the same superiority as that pointed out above, and which depends on its greater rigidity. The blocks of wood, parallelopiped in form, will be easy to make from the butts of rejected cross-ties. If made of beech, they will be creosoted to refusal, which will render the piece of wood antiseptic. If, on the contrary, the heart of oak is employed, a superficial coat will be sufficient to protect the upper face of the block.

In this type the fastenings will be sufficiently solid, by reason of the compression of the wood, especially if the reinforced metallic plate is adopted, and if care is taken to make the entire width of the collar of the screw spike bear on the base of the rail. The employment of treenails can prolong the existence of cross-ties whose fastenings have become bad, but it will not increase their resistance permanently if the wood is not compressed or sustained by a metallic girth. In every case the metallic treenails seem preferable to the wooden treenails, and are equally good in all other ways.

But, if the employment of cross-ties of the determined length is imposed by reason of the stability of the tracks, and if this necessitates the placing of sustaining shoes at the extremities, it is necessary to guard against indiscriminately employing and mixing short cross-ties with long cross-ties. The disadvantages of simultaneously employing cross-ties of different lengths are many; the track becomes rough, and the deformations which are naturally produced are increased.

Mr. Coüard demonstrated that the greatest deformation is produced at the joint; it can attain 0.79 in., and is due to the allowance which must be made when receiving rails from the mill, an

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†Authorized translation by W. C. Cushing, M.A., B.S., Chief Engineer of Maintenance of Way, Pennsylvania Lines West, Southwest System.

allowance which is 0.02 in. at each of its extremities. The rails present the form of an inclined plane, and the depression, which is 0.02 in. in the beginning, increases with time under the influence of shocks, to 0.55 in. With the variable flexure of 0.12 in. which is due to the same cause, and the compression of the ballast, the total deflection is 0.79 in. The support of the joint and the straightening up of the extremities of the rails, in order to avoid all unequal level from the beginning, are absolutely required.

We conclude, then, that, in order to have tracks in a condition for supporting a heavy and rapid traffic, there are necessary:

First.—Cross-ties extremely rigid, two to three times more than those actually in use, which excludes in every case the employment of cross-ties exclusively of steel in the form of a trough.

Second.—The laying of the track with a cross-tie under the joint, that cross-tie being followed and preceded at 11.81 in. with cross-ties equally rigid.

Third.—The use of reinforced plates.

I do not pretend to give definite solutions, but to point out those which appear to me the most logical, and which promise good results. I have outlined a programme which should be followed up, if only partially, in order to verify the truth of my deductions.

I will be glad to have the experiments which I have made repeated, to have them criticised, to have anyone go back to the foundation of things, not being limited, as is now the case, to simply proving by means of ingenious apparatus the deformations produced. It is without doubt excellent to know them; but is it possible to deduce anything from them if the whole cause which has produced them is not sought for first? To repair the track at each point, where these deformations have appeared, is very well for the moment, but, since one has not been to the foundation of things, since the cause has not been destroyed, but only the effect, all that is left is to recommence and always to recommence, which is the work of Penelope.

I intend to continue the studies which I have commenced, to verify still more the observations which I have made, to corroborate them and to enlarge upon them. I only request to be followed, and that such distinguished engineers as the railroad companies possess put themselves to the work, giving account of the many things yet to be done, and how the actual track should be reinforced, if it is desired to increase the speed of traffic, while maintaining the security which it ought to give.

The Cost of Locomotives, 1890-1907.

BY LAWFORD H. FRY.

A number of statements as to the present cost of locomotives have been given out recently in such a way as to convey the impression that modern developments in the art of locomotive building have so increased the cost of locomotives as to lay a serious burden on purchasers. To endeavor to ascertain the truth in this, the order books of a large locomotive works have been laid under contribution and the figures analyzed as described below.

An analysis of figures of this description is necessarily complex, as, while noting changes in price, consideration must be given to the continued growth in the size of locomotives, and to the developments and improvements in design which make for economy in operation and maintenance. Further, in any examination of comparative prices, attention must be given to the demand in which the commodity stands at the period for which the prices are taken.

In order to show the demand which existed for locomotives in the years taken into consideration, the diagram in Fig. 1 has been prepared. This shows the output of the locomotive works, of which the records are being examined, for the last 23 years. On the same diagram is plotted the total steel production of the United States for the same period. It will be seen that the output of steel and the output of locomotives follow a very similar curve, so that the diagram gives a fair measure of the condition of business throughout the country.

The present time is obviously a period of maximum activity. As a period of similarly vigorous demand about 15 years ago, the year 1890 has been chosen.

At the present time the output is nearly three times that in 1890, but this is attributable to a trebled numerical capacity, and not to a relatively greater demand. The increase in the weight of the locomotives makes the tonnage output nearly six times that of 1890. The diagram also shows the variations of prices for steel billets, gray forge pig iron, and for a general average of a number of commodities. The figures for the iron and steel production and prices are taken from the report of the American Iron and Steel Association, while the prices for the general commodities are from Bulletin 69 of the Department of Commerce and Labor. The position of these various curves indicates that at the present time the cost of materials is somewhat higher than in 1890.

The locomotives chosen for comparison are the heaviest freight and passenger locomotives shown by the records as built in the year 1890 and as ordered for the first six months of 1907. Between these two periods there has been a great increase in the size of locomotives, and considerable change in the type employed. The heaviest freight engines of 1890 are moguls with 19-in. cylinders and an average weight of 102,700 lbs., and consolidations with cylinders from 20 to 22 in. in diameter and an average weight of 119,000 lbs., At the present time the heavy freight locomotives are consolidations with cylinders from 22 to 24 in. in diameter, and an average weight of 202,000 lbs. Still larger engines, such as the Santa Fe type (2-10-2), weighing 280,000 lbs., and the Mallet type weighing 350,000 lbs., are also used.

For passenger service the development has been even more striking. The eight-wheel four-coupled American type has been almost entirely superseded for heavy main line passenger service by the Atlantic and Pacific types, the average weight increasing from 93,000 lbs. to 199,000 and 225,000 lbs.

Table 1 shows the number of locomotives taken as a basis of comparison, and gives also the number of railroads represented.

Table 2 gives the average price per pound for the freight locomotives mentioned above. The prices here, as elsewhere throughout the present article, are the actual selling prices of the complete locomotive and tender, divided by the weight of the locomotive in working order. This working order weight of the locomotive is chosen as a basis of reference, because, for engines of a given type

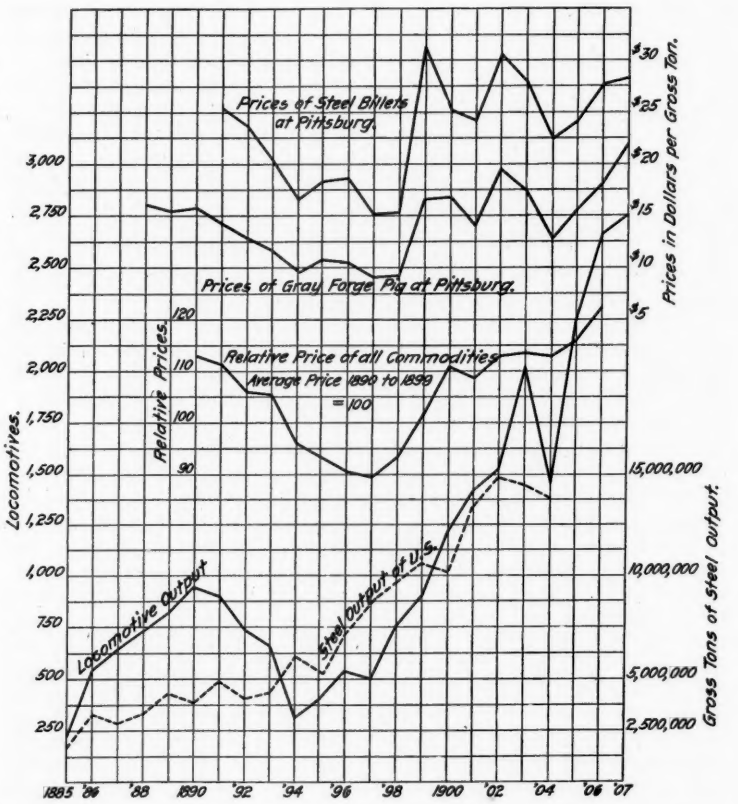


Fig. 1—23 Years' Output of Locomotives and of Steel, With Comparative Prices.

and design, it is quite closely proportional to the usefulness of the locomotive as a means of producing transportation.

If simply the weight of material employed in the construction is taken into consideration, the price of a modern consolidation locomotive and tender is found to be about 7.7 cents per pound of dead weight, while taken separately the locomotive costs about 8.3 cents and the tender about 5 cents a pound.

The relation between these prices per pound of dead weight, and the prices per pound of locomotive in service, will not show any great variation from one period to another, and the service-weight prices are therefore chosen for the purposes of the present article, as they represent more nearly the cost to the purchaser of the useful power of the machine.

It will be seen that table 2 shows a considerable reduction in the price of locomotives from 1890 to the present time. The mogul of 1890 cost 8.89 cents a pound, while the most powerful modern engines can be purchased for less than 8 cents a pound. The average price for consolidation locomotives in 1890 was 8.55, while to-day it is reduced to 8.26 cents a pound. This is merely a comparison of the prices as they stand, and takes no account of the improvements which have been introduced into design and construction. One of the most important changes is the increase in boiler pressure. In 1890 the pressures used were from 130 to 160 lbs. per sq. in. The pressures to-day are from 180 to 220 lbs. per sq. in. From this change results an increase of from 15 to 20 per cent. in the efficiency, per unit of weight. That is, with two locomotives

of the same weight, the modern high-pressure boiler by reason of its higher efficiency, would be capable of developing from 15 to 20 per cent. more power. Hence, if the price for 1890 is to be compared directly with that for 1907, it must be increased about 17½ per cent., so that taking the power into account the average price for 1890 stands at about 10 cents a pound, while the average price for 1897 is 8.26 cents a pound.

The diagram in Fig. 2 shows the variation of price in relation to weight for consolidation locomotives at the present time. The points plotted as circles show the actual prices per pound of total weight for 19 modern consolidations of weights ranging from 73,000 lbs. to 213,000 lbs. in total weight. The prices of these engines as plotted show considerable variation, but at the same time there is a well marked tendency for the price per pound to fall as the weight increases. The curve drawn may be taken as representing

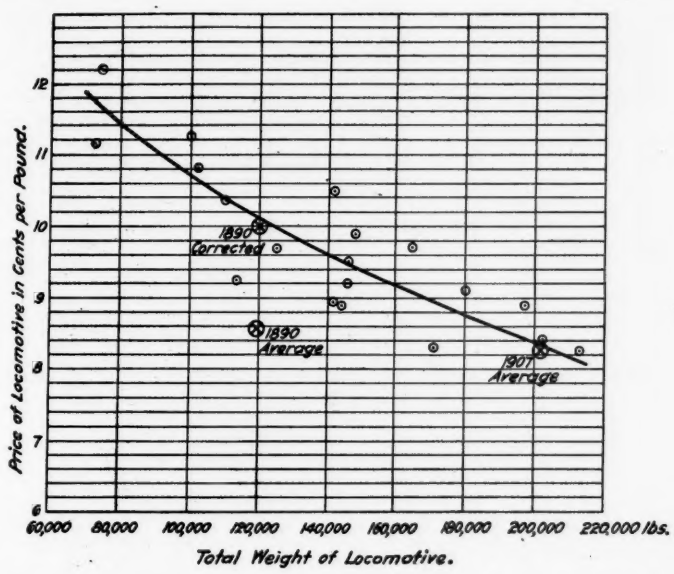


Fig. 2—Relation Between Weight and Price; Consolidation Locomotives.

with sufficient accuracy the relation between the price and the weight. On the same diagram are also plotted the average prices for heavy consolidations in 1890 and 1907, as given in table 2. It will be seen that the corrected price for 1890, and the present average for the heavy consolidations, both fall on the curve of mean prices obtained from locomotives of all weights.

If the cost of operation is taken into account, the economy gained by the development from 1890 to the present time becomes even more apparent. This is shown in table 3.

The average heavy consolidation in 1890 weighed 119,000 lbs., and at 8.55 cents a pound cost $10,175. The modern heavy consolidation averages 202,000 lbs. in weight, and at 8.26 cents a pound costs $16,685. The weight is increased 70 per cent., and since the efficiency is 15 per cent. greater, the power available is 95.5 per cent. higher. The power is practically doubled with an increase in price of only 64 per cent. These figures, as shown by table 3, give a reduction of 16.2 per cent. in the price per unit of power.

The cost of operation is calculated on the basis of the figures given by Mr. Berry, Chief Engineer of the Union Pacific.* For four years on this road the actual charge for locomotive operation amounted to 32.45 per cent. of the total cost of operation.

The details of the charge are shown below, as percentages of the total cost of operation and of the cost of locomotive operation.

	As per cent. of total cost of operation.	As per cent. of cost of locomotive operation.
Repairs and renewal of locomotives	10.19	31.4
Engine and roundhouse men	10.10	31.1
Fuel for locomotives	10.80	33.3
Water, oil, waste, etc., for locomotives	1.36	4.2
	32.45	100.0

The change in these items when the small locomotive of 1890 is replaced by the modern machine with 70 per cent. more power and 15 per cent. greater efficiency is shown in table 3. The cost of repairs and renewals is practically proportional to the power developed. The number of men required for running and cleaning is practically independent of the size of the locomotive.

The cost of fuel is increased in proportion to the increase in size, the increase in efficiency giving the further increase in power without an increase in the fuel consumption. The cost of water, oil, etc., may be taken as proportional to the power developed.

From the above it follows that while the cost for the crew remains the same for the large as for the small locomotive, the costs for repairs and for oil and waste increase 95.5 per cent. in proportion to the increase in power, and the cost of fuel increases 70 per cent. in proportion to the increase in size. This results in an increase of 57.3 per cent. in the cost of operation, while the power developed is increased 95.5 per cent. Consequently, for the modern engine the cost of operation per unit of power is 19.5 per cent. less than for the small and older machine. As was shown above, the prime cost per unit of power is to-day 16.2 per cent. less than in 1890.

The comparisons instituted above have taken account only of consolidation locomotives for both periods. The advantage of the present day is still more strongly shown if account is taken of the mogul type, which was largely used for freight service in 1890, and which has been now practically superseded by heavier and more economical types.

Comparative prices for the passenger locomotives are given in table 4. It will be seen that as the figures stand, they show a slight increase in the price per pound for the single-expansion Atlantic type locomotives in 1906 and 1907, compared with the American type locomotives of 1890; while the balanced compound Atlantic type and the single-expansion Pacific type engines of 1907 show a reduction in cost, which is most marked in the case of the last mentioned type. Among the passenger locomotives the power is better measured by the heating surface than by the total weight, and the prices of these engines are therefore given per square foot of heating surface as well as per pound of weight. On this basis the economy of the modern locomotives is more strongly marked. The growth in size and efficiency will, as in the case of the freight engines, reduce the cost of operation, the percentage of economy being even greater than that shown by the freight engines. The reduction in the price per unit of power amounts to 13.5 per cent. for the single-expansion Atlantic type, 21.6 per cent. for the balanced compound Atlantic type, and 26.6 per cent. for the Pacific type. The reductions in the cost of operation are 21.5, 25.6 and 26.6 per cent. respectively for the three modern types.

The economies which the purchaser secures by the use of the large modern locomotives are due partly to their mechanical advantages, and partly to the commercial fact that it is impossible for the manufacturer to increase prices at a rate commensurate with the growth in the size of the locomotives and the increases in the cost of manufacture. The diagram in Fig. 3 illustrates the tendency of the selling price to approach the cost of manufacture as the total cost increases, thus reducing the percentage of profit.

The same principle operates in the case of increases in the cost of manufacture, by reason of a rise in the price of labor or of raw materials. The manufacturer, by reason of the exigencies of competition, cannot secure an increase of price of the same per cent. as the increase in cost, and he is consequently forced to accept a continually decreasing return on his invested capital.

In building locomotives or other heavy machinery, the cost of labor is the controlling factor. The locomotive builder's charges cover cost of materials, cost of labor, return on capital. The return obtainable on the capital, as seen above, has a constant tendency to decrease, and consequently any increases in the cost of the machine is brought about by an increase in the cost to the builder, of the materials or of the labor. On further analysis it will be seen that the cost of the materials is mainly dependent on the price which the manufacturer of them has to pay for the labor he employs. The cost of all material used in locomotive construction is mainly the following items:

a. Cost of labor.
b. Cost of transportation.
c. Royalties and return on capital.

Inasmuch as none of this material is the subject of a monopoly, the cost of royalties and the return on the capital invested, are held to a level by the force of competition. The cost of transportation tends to decrease rather than to increase, and the only item

*"The Cost of Locomotive Operation," by G. R. Henderson, p. 2.

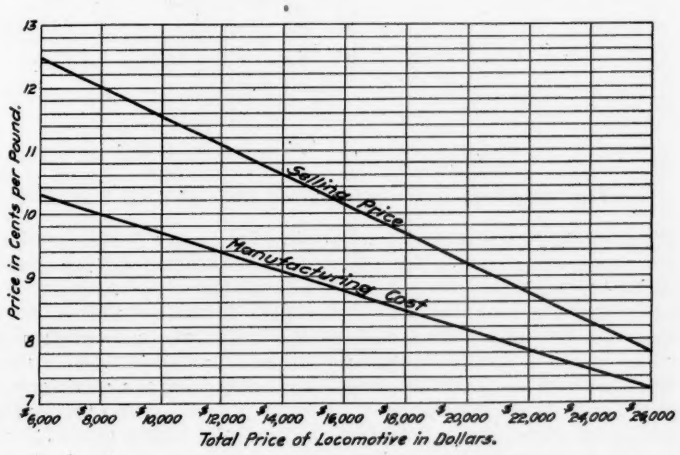


Fig. 3—Relation of Cost to Selling Price.

of cost which is open to an uncontrolled rise is the remuneration demanded by labor. This is merely saying that the price of commodity is determined by the relation between supply and demand, and that in the production of engineering materials in this country, labor is the only factor of which the supply is sufficiently restricted to make possible an increase in the price with an increase in demand. Royalties on any material are obtainable by those controlling the processes of manufacture or the source of supply, but of the materials employed in locomotive building none are monopolized. There is always an alternative process of manufacture, or an article which may be substituted to avoid excessive patent royalties, and the sources of supply are varied enough to meet all demands. The return claimed by the invested capital is at all times held down by the very keen existing competition, and by the ease with which capital could be secured for further competition if the returns were at any time forced above the normal. The transportation charges are held down by competition and consideration of what the traffic can bear. There is, however, not an unlimited supply of engineering labor, and as prosperity in the country demands an increased output, labor is able to take advantage of this condition and increase the remuneration required.

Table 1.—*Number of Locomotives and Railroads Compared.*

Year.	Locomotives. Class of	No. of.	Number of railroads.	Av'g total weight in lbs. of locomotive in working order.	Cylinder diam. & No. of locos. hav'g each diameter— Cyl'd'r diam.	No. of locos.
1890	Mogul	61	6	102,700	19	61
1890	Consolidation	159	14	119,000	20	
					21	17
					22	3
1890	American T.	19	6	93,000	18	14
					19	2
					20	3
1907	Consolidation	185	14	202,000	24	3
'06-'07	Santa Fe.	..	..	280,000	Comp.	..
'06-'07	Mallet	..	..	350,000	Comp.	..
1907	Atlantic	30	3	199,000	Bal. Comp.	..
1907	Pacific.	128	4	225,000	22	128

Table 2.—*Prices of Heavy Freight Locomotives.*

Year.	Type of locomotive.	Average weight.	Price, per lb.
1890	Mogul single expansion	104,000 lbs.	8.89 cents.
1890	Consolidation single expansion	119,000 "	8.55 "
1907	Consolidation single expansion	202,000 "	8.26 "
1907	Mallet type compound	350,000 "	7.80 "
1907	Santa Fe type compound.	285,000 "	7.70 "

Table 3.—*Consolidation Freight Locomotives—Cost of Power and Operation.*

Year.	1890.	1907.
Total weight, in lbs.	119,000	202,000
Total price	$10,200	$16,685
Price in cents per lb.	8.55	8.26
Relative weight	100	170
Relative efficiency, per unit of weight	100	115
Relative power	100	195.5
Cost of operation:		
Repairs and renewals	31.4	61.4
Engine and roundhouse men	31.1	31.1
Fuel	33.3	56.6
Water, oil, waste, etc.	4.2	8.2
	100.0	157.3
Relative price per unit of power	100	83.8
Relative cost of operation per unit of power	100	80.5

Table 4.—*Prices of Passenger Locomotives.*

Year.	Type of locomotive	No. represented in comparison. Roads.	Locos.	Average weight, lbs.	Average heating surface, sq. ft.	Av'g price— Per lb.	Per sq. ft. of h.s.
1890	4-4-0 Sim. exp.	7	19	97,000	1,540	8.85c.	$5.65
1907	4-4-2 Comp.	3	30	199,000	3,190	8.82c.	5.50
1907	4-6-2 Sim. exp.	4	128	225,000	3,930	8.31c.	4.76
'06-'07	4-4-2 Sim. exp.	4	18	180,000	2,940	9.20c.	5.63

Table 5.—*Passenger Locomotives—Cost of Power and Operation.*

	1890. Single-expansion.	1906-7. Atlantic.	1907. Bal. comp.	1907. Single-exp. Pacific.
Type of locomotive	American.			
Total weight	98,000 lbs.	180,000 lbs.	199,000 lbs.	225,000 lbs.
" heating surface	1,540 sq. ft.	2,940 sq. ft.	3,190 sq. ft.	3,930 sq. ft.
" price	$8,700	$16,550	$17,570	$18,700
Price, per lb.	8.86 cts.	9.20 cts.	8.82 cts.	8.31 cts.
" per sq. ft., htg. surf.	$5.65	$5.63	$5.50	$4.76
Relative weight	100	184	205	230
" heating surface	100	191	207	255
" effic. pr unit w't.	100	115	125	115
" power	100	220	259	293
Cost of operation:				
Repairs and renewals	31.4	69.0	81.4	92.0
Eng. and roundhouse men	31.1	31.1	31.1	31.1
Fuel	33.3	63.6	68.9	79.5
Water, oil, waste, &c.	4.2	8.2	10.9	12.3
Total	100.0	172.9	192.3	214.9
Per unit of power:				
Relative price	100.0	86.5	78.4	73.4
Relative cost of operation	100.0	78.5	74.4	73.4

A Berlin engineer has invented a process for aerating the water in the tank cars in which live fish are transported to market. To make such transportation profitable there must be many fish in a comparatively small quantity of water, and these exhaust the oxygen very much as a throng of animals exhausts the air in an air-tight room or car. The new method avoids this by putting receptacles containing compressed air on the floor of the tank, which discharge air slowly into the water and so make it fit for the consumption of the fishes even when pretty closely packed. Great fish merchants have used such a car between Berlin and the sea, and, it is said, with very satisfactory results. Of course the same method could be applied to tanks in vessels.

Recent Developments in Air Brake Control Apparatus.

BY F. H. PARKE AND S. W. DUDLEY.

The two most important factors in originating and directing the course of the recent rapid developments and fundamental changes in the control apparatus of the air brake have been, 1st, the broadening of the field of its application to include electrically operated railways, and, 2d, the enormous growth in rolling stock of all kinds, and consequent increase in the requirements of train operation.

As recently as three years ago the various standard types of air brakes, which had then for some time been in use, were deemed

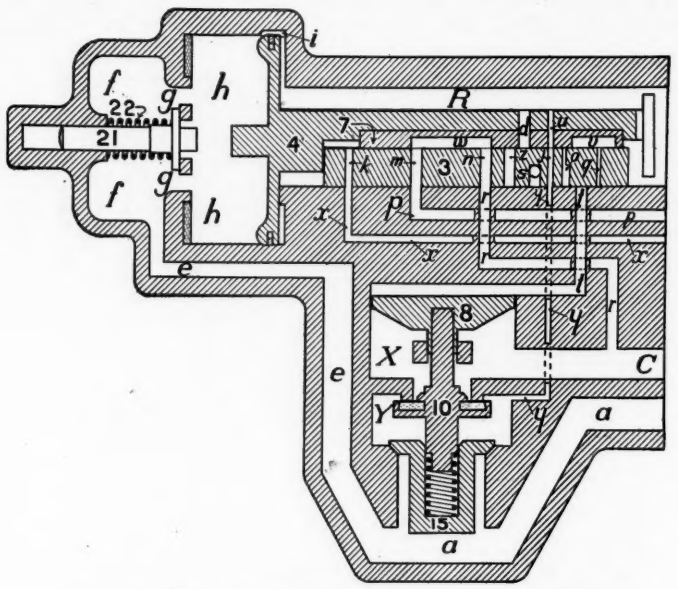


Fig. 1—Type R Triple Valve; Release Position.

ample to meet all possible operating demands. But the increasing requirements of surface traction, which was rapidly passing from almost universal single car operation to that of trains, made it desirable to substitute an automatic brake for the straight-air systems then in general use, which should combine to the highest possible degree the safety of the automatic brake and the flexibility of operation of the simple straight-air control.

THE AUTOMATIC AIR BRAKES.

Before proceeding further, it may be well to describe briefly the principle governing the automatic brake: Each vehicle has a

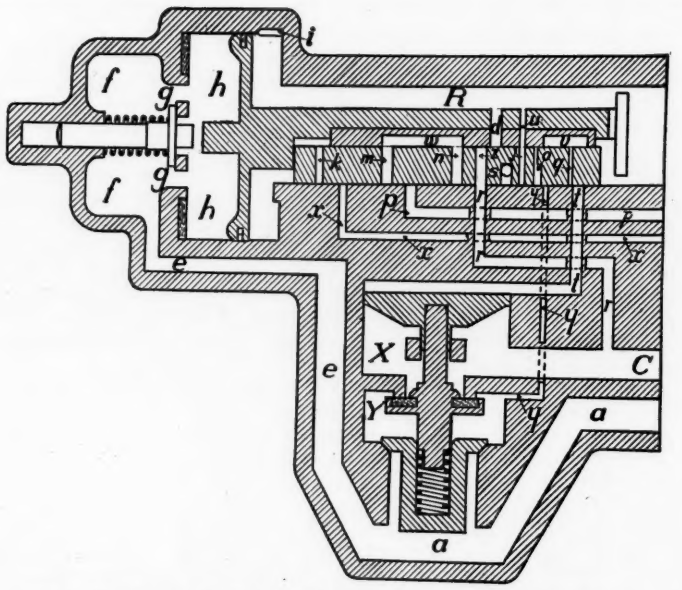


Fig. 2—Type R Triple Valve; Service Lap Position.

pipe, called the brake pipe, running its entire length, with hose couplings on each end for connection to adjacent vehicles; also an auxiliary reservoir, in which is stored the air supply for use in operating the brakes on that vehicle; a brake cylinder with piston and rod, the latter connected to the brake shoes through suitable rods, levers and brake beams; a triple valve which forms the connection between a branch from the brake pipe, the auxiliary reservoir, and the brake cylinder, in such a way as to (1) charge the auxiliary reservoir by connecting it to the brake pipe, (2) apply the brakes by connecting the auxiliary reservoir to the brake cylinder, and (3) release the brakes by connecting the brake cylinder

with the atmosphere. The principal element of the triple valve is a piston, the rod of which moves a controlling slide valve. Brake-pipe pressure is always present on one side of this piston and auxiliary-reservoir pressure on the other, so that the operation of this valve, and therefore of the brakes, depends on the difference between these two pressures. As the brake pipe extends through the entire train, a means is thus provided for operating the brakes on each car from the leading vehicle, namely, by altering the brake-pipe pressure. It is lowered to apply the brakes and increased to release them, thereby embodying the essential feature of an automatic brake, because, if any rupture occurs in the brake pipe or its hose connections, the pressure is at once reduced and the brakes are automatically applied.

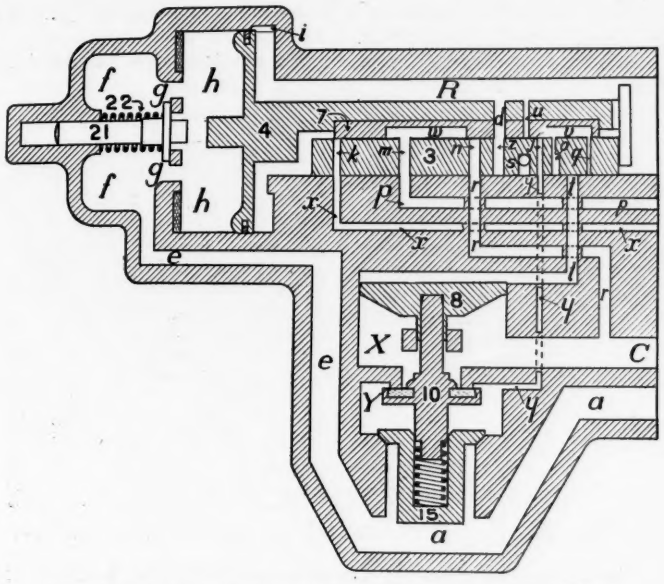


Fig. 3—Type R Triple Valve; Release Lap Position.

THE STRAIGHT-AIR BRAKE.

The straight-air brake, on the other hand, has no auxiliary reservoir nor triple valve. It has no supply stored on each car, nor any pressure in the brake pipe when the brakes are not applied. It depends on the supply stored in a single reservoir on the leading vehicle, which is admitted through the brake pipe directly to the brake cylinders to apply the brakes, and released from the pipe and cylinders to release the brakes. This, of course, means no braking power if any part of the piping system is ruptured even in single car operation, but a very accurate means of controlling the cylinder pressure (in short trains) both in applying and releasing, thereby constituting the feature of flexibility.

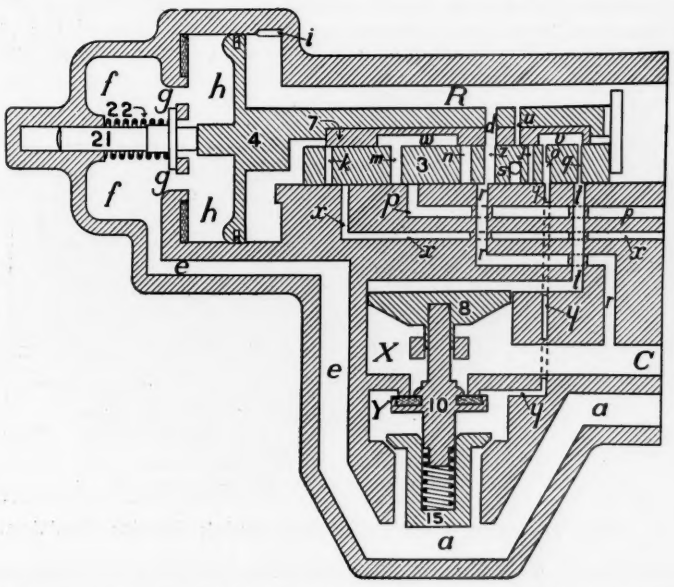
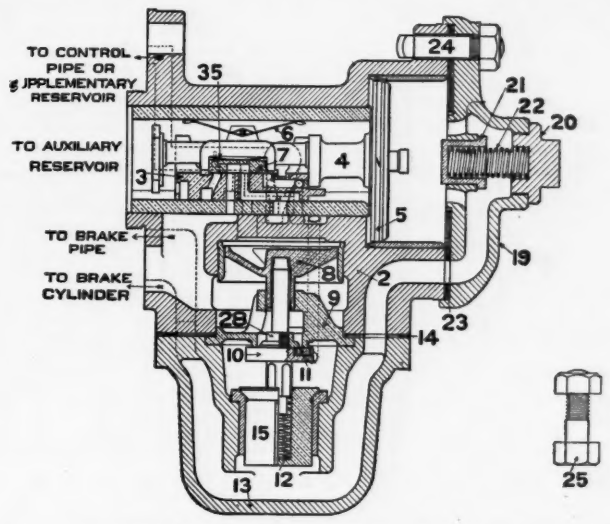


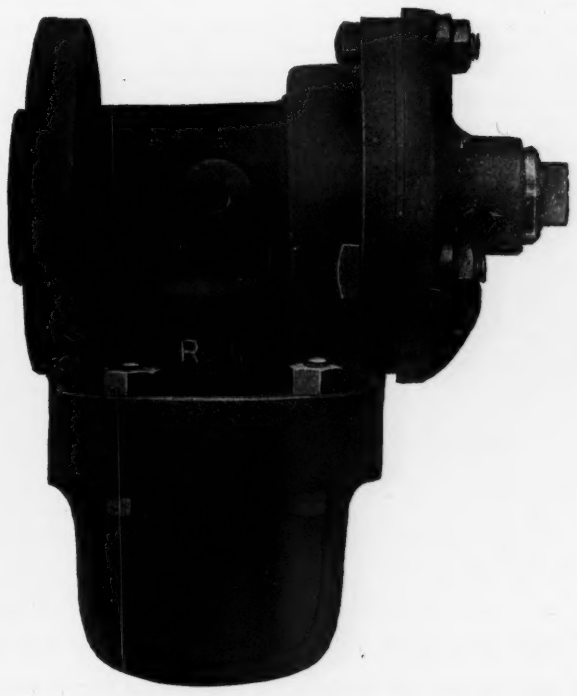
Fig. 8—Type R Triple Valve; Quick Service Position.

The prominent operating feature of the straight-air brake system, which contributes largely to its flexibility, and which until lately has been lacking in the automatic system, is the ability to release the brakes gradually. This enables the operator to approach the stopping point at a high rate of speed and apply the brakes with full power. Then, as the speed is reduced, he is able to accommodate the retarding force to the decreasing amount of energy to be overcome and the increasing coefficient of friction, by reducing the brake-cylinder pressure in a series of steps or graduations. Therefore, at all times, during the stop, there is being exerted a retarding effort which is the maximum permissible at that particular instant consistent with smooth handling and the absence of wheel sliding. Futhermore, this ability to control the release of the brake-cylinder pressure enables the stop to be made with the greatest possible accuracy. These features of operation are essential in a service where fast schedules and frequent stops are required. However, when train operation is introduced, not only is the flexibility of the straight-air system seriously interfered with, but the consideration of safety becomes of prime importance. Any parting of the train or rupture in the hose or piping connections would result in instant and total loss of braking power, and this would be most likely to occur just when full retarding power was most needed.



Section Through Type R Triple Valve.

As the automatic-brake system was primarily designed to meet this contingency and prevent the possibility of such a loss of braking power, it was evident that the time had come when it was necessary to evolve a system which would combine the flexibility of the straight-air with the safety of the automatic system. It was therefore manifest that such a new system must, whatever else was included, have as its fundamental characteristic, the automatic feature. This meant that the automatic brake as then known would have to be so modified as to include the principal features of flexibility characteristic of the straight-air systems, viz.: the graduated release, and the ability to make brake applications in rapid succession. This latter feature depends on the rapidity with which the auxiliary reservoirs can be recharged, after an application and release are made. Consequently the two necessary features to be incorporated in the old automatic brake were the graduated release and quick recharging of the auxiliary reservoirs. This meant a



Type R Triple Valve.

modification in the triple valve to include the points mentioned in addition to the functions which it already performed.

GRADUATED RELEASE.

Considering first the means adopted to secure a graduated release: The operation of the triple valve is governed by the difference in brake pipe and auxiliary reservoir pressures, acting on the opposite sides of the triple valve piston. To apply the brakes, a reduction in brake-pipe pressure is made, which leaves a higher pressure on the auxiliary reservoir side. The piston is consequently forced toward the lower pressure, carrying with it the attached slide valve which in its movement opens communication between the auxiliary reservoir and brake cylinder. This causes the pressure in the reservoir to be reduced, by the flow of air to the brake cylinder,

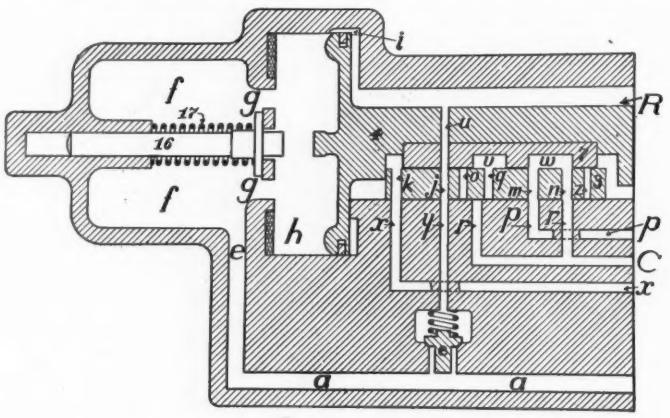


Fig. 4—Type T Triple Valve; Release Position.

until it has fallen to slightly below that remaining in the brake pipe. The pressure on the brake pipe side of the piston being now slightly in excess, the piston and slide valve are moved back sufficiently to prevent further change of pressure.

In order to release the brakes, when thus applied, an increase in brake pipe pressure is necessary. This will force the piston and slide valve back to its normal or release position, allowing the brake cylinder pressure to escape to the atmosphere, and at the same time recharging the auxiliary reservoir. This would continue until the brakes were wholly released, and the reservoirs fully recharged, unless in some way the triple valve piston could be moved back from the release position to cut off the exhaust of brake cylinder pressure, and the flow of air to the auxiliary reservoir. This was impossible with the old standard types of triple valves, as the pressure in the auxiliary reservoir was dependent upon the air supplied to it from the brake pipe only, and therefore manifestly it could never exceed the brake pipe pressure during the release or move the piston and slide valve from release position. But suppose that a reserve supply of air at maximum brake-pipe pressure

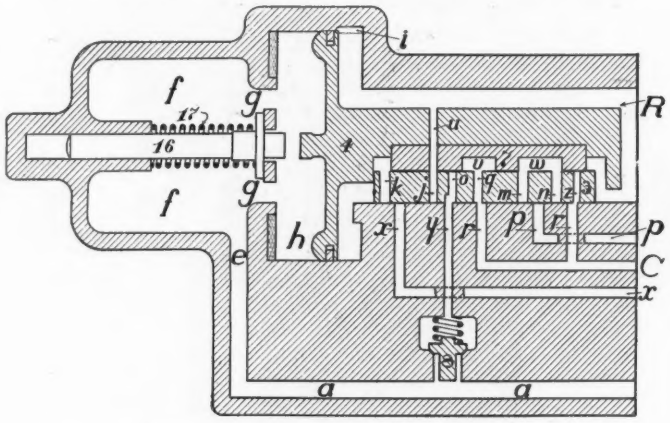


Fig. 5—Type T Triple Valve; Service Lap Position.

is so connected to the triple valve that it can flow to the auxiliary reservoir only when the triple valve piston is in release position, and suppose that after an application, only a part of the reduction is restored to the brake pipe. The triple-valve piston goes to release position, as before, but the connection then made with the reserve supply allows air to flow to the auxiliary reservoir, thus helping to recharge it. If allowed to continue, this would raise the auxiliary-reservoir pressure to tnat of the reserved supply. But this does not occur, since when the pressure in the auxiliary reservoir slightly exceeds that now in the brake pipe, the triple valve piston is caused to move back from the release position sufficient to cut off both the brake cylinder exhaust and the connection to the reserve supply. In this way partial releases may be made until the brake cylinder is entirely exhausted.

The method employed in working out the above in the actual triple valve is illustrated in Figs. 1 to 7. These views, it must be borne in mind, are purely diagrammatic, bearing no relation to the actual construction of the valve, but showing all the ports and passages in one plane and connected in the simplest possible manner. The different connections to the triple valve are as follows:

Brake pipe at *a*, brake cylinder at *c*, the reserve supply at *x*, while *p* is the exhaust connection to the atmosphere, and *R* is always in communication with the auxiliary reservoir.

It is clear from the illustrations that, as in the standard types of triple valves, the triple valve piston has brake pipe pressure on one side, namely, in chamber *h*, and auxiliary reservoir pressure on the other, namely, chamber *R*.

Suppose the brakes to have been applied by a 15-pound reduc-

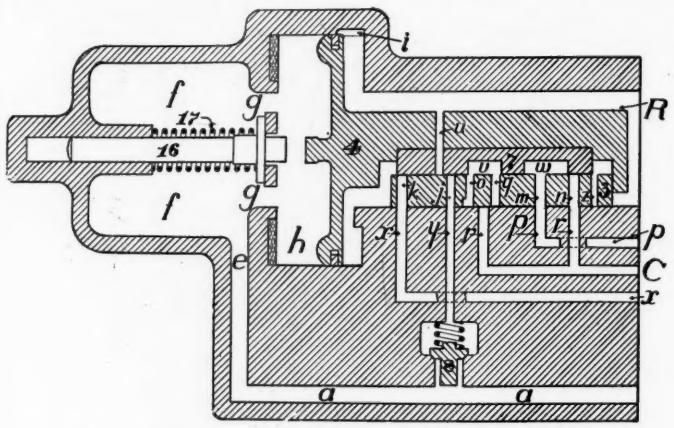


Fig. 6—Type T Triple Valve; Release Lap Position.

tion in brake-pipe pressure, and assume the initial pressure to have been 70 pounds. As soon as the pressure in the auxiliary reservoir has fallen slightly more than 15 pounds the valve will be returned to service lap position shown in Fig. 2. There is now 55 pounds in the brake pipe and auxiliary reservoir, while 70 pounds is still available in the reserve supply and port *x*. Suppose now the brake-pipe pressure be increased 5 pounds. The piston and slide valves will be returned to release position, as shown in Fig. 1, in which position the auxiliary reservoir is being recharged from two different sources, through three different channels. Air from the brake pipe passes through the feed groove *i*, as usual, and also, lifting the check valve, through passage *y*, in the valve body, *j*, in the main slide valve, and *u* in the graduating slide valve to the chamber *R*. At the same time air from the 70-pound reserve supply feeds into chamber *R* through ports *x* in the valve body and *k* in the main slide valve. By this means the auxiliary reservoir pressure is increased until it has reached slightly more than 60 pounds, when this increased pressure on the reservoir side of the piston over that on the brake-pipe side causes the piston and graduating

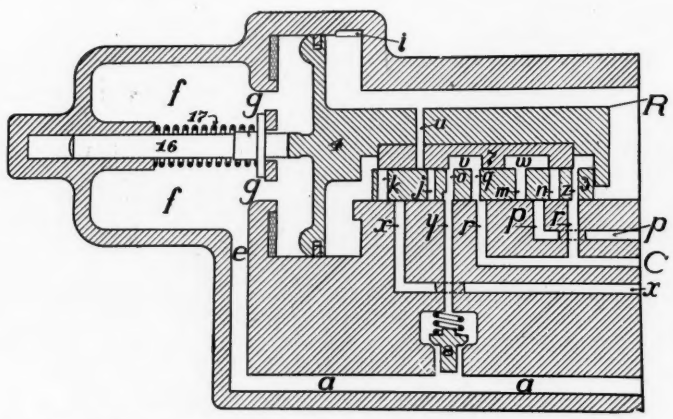


Fig. 7—Type T Triple Valve; Quick Service Position.

valve only to move to the left until the piston stem strikes against the slide valve. This movement closes ports *k*, *j*, and the brake cylinder exhaust port *r*, thus preventing further escape of air from the brake cylinder. This position, known as release lap, is illustrated in Fig. 3.

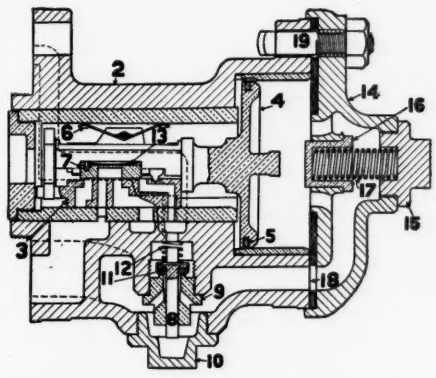
If the brake-pipe pressure is raised 5 pounds more (to 65 pounds), the operation described above will be repeated, allowing a further portion of the air remaining in the brake cylinder to escape. This operation may be repeated, thus exhausting the cylinder, and recharging the auxiliary reservoir in a series of steps until the brake is fully released and the auxiliary reservoir fully recharged. Thus a simple and adequate means is provided for graduating the release of the brakes, positive in its action and sensitive enough to meet all the requirements of service.

QUICK RECHARGING.

In the graduated release operation the auxiliary reservoir is being recharged through three different ports, instead of one (the feed groove *i*), as formerly, and in such a manner that the rise in auxiliary reservoir pressure is proportional to the fall in cylinder pressure, so that when the release of the brake is complete, the auxiliary reservoir is practically fully recharged and ready for an immediate reapplication if necessary. Having these features incorporated in the automatic system the flexibility of straight-air operation is closely approximated without in any way impairing the safety features of the automatic control. In fact, a distinct advantage from the standpoint of safety is gained by the quick recharge feature, which insures, at all times, the possibility of full braking power being developed, without regard to the length of time intervening after a release—a condition not even approximated by either the straight air or former automatic systems.

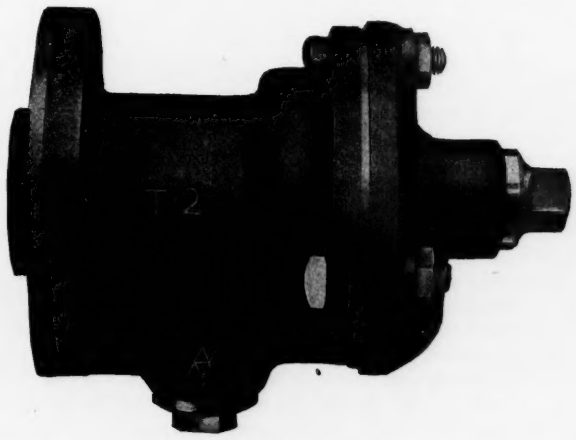
TRIPLE VALVES FOR SINGLE CARS.

The quick action features of a triple valve consist of the check valve 15, rubber-seated valve 10 and piston 8, shown



Section Through Type T Triple Valve.

in Figs. 1 to 7. In an emergency application, auxiliary-reservoir pressure is admitted above piston 8, which causes it to unseat valve 10, and allow air from the brake pipe to raise check valve 15 and flow rapidly to the brake cylinder through chambers *Y* and *X* until the brake cylinder and brake-pipe pressures become equalized. The check valve then seats and prevents cylinder pressure from flowing back to the brake pipe. This is the means employed for hastening the brake-pipe reduction throughout the train, as each triple valve vents a portion of the brake-pipe air to its cylinder, which similarly affects the triple valve on the next vehicle, and so on through the train. It also raises somewhat the cylinder pressure obtained, due to the air introduced from the brake pipe. If the brake-pipe reduction is considerably more rapid than the reduction in auxiliary reservoir pressure due to its flow of air to the brake cylinder, the triple-valve piston will assume



Type T Triple Valve.

the emergency position, which will result almost instantly in an application with maximum braking power.

Although the features of graduated release and quick recharging were originally developed in connection with the quick-action triple valve, they can just as readily be incorporated in the plain type of triple valve; that is, one without the quick-action features. This was the next step taken.

PLAIN TRIPLE VALVE WITH GRADUATED RELEASE AND QUICK RECHARGE.

The first form of plain triple valve to be designed to embody the features of graduated release and quick recharge of auxiliary reservoir was for train operation limited to two cars. With this valve the graduated release feature was obtained by piping the exhaust of the triple valve to the brake valve, where the air contained in the brake cylinder would either be retained or allowed to escape to the atmosphere at the will of the motorman. The quick recharging feature was obtained in this valve by means of a small check valve which allowed the brake pipe air to flow directly to the auxiliary reservoir when the triple piston was in release position. A further detailed description of this valve will be unnecessary, as all of its features are embodied in the plain triple valve which followed it, which was designed for use on cars to be operated singly or in trains up to five units. This valve, designated as the type T triple valve, is shown in Figs. 4, 5 and 6.

In Fig. 4, port *a* connects with the brake pipe, port *x* with the reserve supply, port *c* to the brake cylinder, and *p* to the exhaust through the brake valve, while *R* is in connection with the auxiliary reservoir.

Quick recharging is obtained partly through the small check valve shown, which connects *a* through ports *y*, *j* and *u* with the auxiliary reservoir, and partly through ports *x* and *k* from the reserve supply. The graduated release of the brakes is obtained in exactly the same way as previously described for the quick-action triple valve, as will be evident at once from Figs. 5 and 6, the ports being lettered identically. One feature in connection with this valve, however, deserves particular notice. The exhaust port *p* being connected by piping to the brake valve, combined with the use of the reserve supply as previously described, affords two means by which a graduated release of the brakes in the train may be made. The method of graduating the release by means of the reserve supply, in the manner already explained, gives a graduated release on all the cars in the train, while the second method enables the operator to govern the release of the brakes on the head car alone, directly at the brake valve. This latter method makes possible a very flexible control when operating as a single car, and is known as the straight-air release feature.

The application of these valves to trains up to five cars in a service in which frequent stops from a fast schedule were required, made clear the desirability of a more rapid service application of the brakes throughout the train. The modifications already made in the triple valves to obtain the quick recharge feature were easily adapted to produce a quicker service application of the brakes than had previously been possible where the brake-pipe reduction was dependent upon the air contained in the pipe flowing the whole length of the train to the brake valve before it could escape to the atmosphere.

In emergency a rapid serial application of the brakes is obtained by venting a portion of the brake-pipe air to the brake cylinder on each car. This affords a means of escape for the brake pipe air, without all of it having to flow the length of the train to the brake valve. This same method suggested itself for quickening the service application, the action being of the same character as that in emergency, but to a less degree. As there was already a port connecting the brake pipe to the slide valve seat, which in release position affords a means of securing a quick recharge, it was only necessary to add ports to the slide valve, which, in the movement to service position, connect the brake pipe through these ports to the brake cylinder. In this manner a slight reduction in brake-pipe pressure is effected during a service application by each triple valve in turn. By this means the time required to apply the brakes in service is materially reduced.

In Fig. 4, the additional ports just mentioned are marked *o*, *v* and *q*. In the quick service position, port *o* registers with port *y* (see Fig. 7), and cavity *v* in the graduating valve connects ports *o* and *q* in the main slide valve, the latter registering with port *r*, leading to the brake cylinder, thus establishing direct communication from the brake pipe through the check valve to the brake cylinder. When the piston returns to lap position, Fig. 5, the quick service ports *o* and *q* are blanked by the graduating valve. This feature proved to be so easily obtained and of such decided advantage that it was incorporated in all the triple valves designed for use in trains of more than two cars.

Referring to Fig. 8, showing in quick service position the quick-action triple valve already described, it will be observed that the port *q* connects with port *t*, which leads to the top of the emergency piston instead of directly to the brake cylinder, as in the preceding valve. This arrangement was simply a matter of convenience, as the port *t* was already conveniently located for the purpose, and the emergency piston is of sufficiently loose fit to allow the relatively small amount of air thus discharged to pass readily around it and to the brake cylinder without any danger of causing the quick action parts to move.

Referring to Fig. 8, it will be noted that when quick-service port *y* registers with port *o* in the slide valve, the service ports *d* and *r* only partially register; the air flowing through these ports from the auxiliary reservoir to the bake cylinder is thus restricted in amount, which limits the rate at which the auxiliary-reservoir pressure reduces. If the brake-pipe pressure reduces more rapidly than does the auxiliary-reservoir pressure, the predominance of pressure in chamber *R* will enable the piston to somewhat compress the graduating spring and move the slide valve to the "full service" position shown in Fig. 9. In this position port *y* is closed, prevent-

ing a flow of air from the brake pipe to the cylinder, while port *r* is fully open, allowing a more rapid flow from the auxiliary reservoir to the brake cylinder, so that the reduction in auxiliary-reservoir pressure may keep pace with that in the brake pipe. In this way the triple valve automatically cuts out the quick-service feature when it is not needed.

(To be concluded.)

The Use and Abuse of Fire Brick for Locomotive Fire-boxes.

BY J. E. BOND.

Fire brick arches have been used for so many years in locomotive fireboxes that the purchasing departments and motive power departments of the railroads, as well as the manufacturers of fire brick for this purpose, seem to have fallen into a rut, and apparently the subject is not receiving the attention it deserves. In the opinion of the writer there is room for improvement in both the manufacture and use of fire brick arches.

Cold air after extreme heat is the hardest test of a good fire brick. It is a regular occurrence, on most roads, to run an engine over the ash-pit at the end of a run, turn on the blower and knock out all the fire. The cold air striking the red-hot bricks cools the outside, and, unless properly made, the bricks crack and are destroyed. Experience has shown the writer that a fire brick can be made by any of the larger manufacturers that will increase the life of the arch an average of 100 per cent.; that is, while on most roads the fire brick arch lasts from ten days to two weeks, by giving proper attention to the design and mixture of the clay, the average life could be increased to from 20 days to a month.

Manufacturers generally have an idea that the vibration of the locomotive is a great factor in the destruction of the arch, and that a tile must be made of such a mixture as will give as great physical strength as possible. As a matter of fact, vibration is a small factor in the destruction of the arch. The writer realizes that each clay requires a peculiar treatment of its own to get the best results; that a method of handling the clay in a given district would not be successful with another clay, even a few miles distant. Therefore, it is impossible to have a specific rule that will apply to all clays, but there are certain general details that apply to the manufacture of all fire brick.

For the benefit of those not familiar with the subject, a brief description of the process will be given. Fire clay usually occurs under coal measures and is virtually a pure clay. The chemical analysis is of great importance in certain lines of work; it is of less importance in railroad work than the physical qualities, since the gases of coal do not cause much deterioration, unless there is a considerable percentage of iron in the clay, when the sulphur of the coal may unite with the iron pyrites and cause injury to the brick. Fire clay is mined about the same as coal. When it first comes from the mine it is as hard as stone and fractures of the clay will be so sharp that the pieces will cut the hands. The clay is of three general varieties: plastic, semi-plastic and flint. The first, when tempered, becomes like putty and is easily worked with the hand. The second, if exposed to the weather sufficiently, or if sufficiently tempered, will also become plastic. The flint clay will not become plastic when exposed to weather, but will break up into small crystals if exposed for some time. The chemical analysis of these three clays may be identical. The clays are ordinarily pulverized in a dry pan crusher, and mixed with calcine (burned fire clay) ready for tempering. The tempering is ordinarily done in a wet pan. The clay is taken from the wet pan to the moulders, where it is moulded into the desired shapes by hand. It is then placed on a hot floor, where it is dried, and afterwards burned in a kiln at a temperature of about 3,000 deg. F., after which it is allowed to cool down slowly for a number of days before opening the kiln.

Now it is the mixture of the clays that determines the character of the brick. For high grade, such as is used in blast furnaces, steel furnaces, etc., the mixture is largely flint and calcine, with just enough plastic clay to form a bond to unite the particles. It is made in as soft mud as will retain its shape after being moulded. When this is dry it is exceedingly porous and is not physically strong. It is nearly white in color after burning and when fractured can be pulled apart by the fingers in many cases. However, when this brick is subjected to high heat and sudden changes of temperature it does not crack or check because its porosity enables it to cool more uniformly throughout its mass. The expansion and contraction is also much less than in the more plastic kinds of brick. High grade bricks will not answer for all purposes, since they are too easily injured by abrasion. For instance, in the top of a blast furnace, where the charging of the furnace would destroy high grade brick, it is necessary to use more plastic clay and less flint.

A great deal of study has been given by iron and steel makers, as well as by manufacturers of fire brick, to get up a material exactly suited to each process connected with the art. It is not advisable to make locomotive tiles of the same mixture as high grade brick because they would not have sufficient strength to get them into the fireboxes; but the mixture should approach nearer to the high grade than that which is generally supplied to railroads. Now the higher the proportion of flint clays and calcined clay used up to the point that will be bound together, the greater the heat and the variations of temperature the brick will stand, but the more delicate the brick will be to handle cold. Conversely, the greater the proportion of plastic clays used in the mixture, the less change of temperature it will stand, but the stronger physically the brick will be while cold. It is not altogether the fault of the manufacturer that he makes his mixture too low a grade to stand the changes of temperature incident to the locomotive operation. It costs him no more, ordinarily, to make a high grade than a low grade brick, but the designs submitted will not stand up in the higher grade material. It is therefore up to the railroads to design a brick that will stand.

But it is impossible for a designer, who is not familiar with the processes of manufacture to design fire brick intelligently. It would be money well spent to send the designing engineer to the fire brick factories to spend as long a time as he needs to get an insight into the business, and that he may co-operate with the manufacturer in getting out designs that can be made. As a case in point, a manufacturer of fire brick in Missouri showed the writer a design from a prominent western road that called for iron bars in the tiles to strengthen them. They ran the entire length of the arch. This manufacturer simply made holes through the tiles, which were for wide firebox engines, and told the railroad people they could supply their own iron. For it is well known by all who are familiar with the art that iron heated to the temperature of the firebox has little or no strength, even if it is not melted, and had the iron been placed in the tiles before burning, it would have been melted long before the furnace attained the heat necessary to burn the brick, and would have ruined any other bricks in the kiln as well.

Most roads make tiles for wide firebox engines in two sections, butting the tiles together in the middle of the firebox. This the writer believes to be wrong in principle where arch tubes are used. There are usually four tubes to support the tiles. The joints should be made over the tubes in order that there be as little overhang or cantilever as possible. Now, because the tubes, containing water, keep the adjacent part of the tile cooler than the part which is away from the tube, this causes the material to expand on the top of the tile and remain contracted on the lower side, causing the tile to droop and gradually to fracture. Then when a rough place is produced by the drooping of the tile, the action of the gases and cinders becomes much greater at this point, causing more rapid abrasion. In narrower types of fireboxes containing two tubes it is better to make a joint over each tube, with a special tile supported on studs in the side sheets for the ends; or make the end tile longer so that the end resting on the tube is lower than the end resting against the side sheet. The studs can thus be dispensed with.

The writer has seen large quantities of fire brick arches stored in the open air on certain roads in the West and Northwest. Nothing could be worse for fire brick of a quality good enough to stand the changes of temperature than exposure to winter weather, for the reason that a good fire brick is exceedingly porous and absorbs a great deal of water. When the water freezes it expands and fractures, if it does not break, the brick. It is economy to erect good dry storage sheds for all fire brick. Even the moisture absorbed from the atmosphere makes a brick more delicate in cold weather. Summer rains are not so injurious as the winter rains.

Complaint came to the writer that a certain road was having heavy loss in its locomotive tile. It was high grade material and should have yielded good results. Investigation revealed the fact that the tiles were piled 20 to 25 ft. high in a shed. It was being handled by cheap help, and indeed the breakage was a serious item. Manufacturers seldom, if ever, pile fire brick to exceed 8 ft. high because it is not strong enough to withstand the pressure incident to higher piling, especially in the winter when frost weakens the material.

Another abuse often seen is to bring tiles covered with ice into the roundhouse, install them in a firebox and then build a fire under the arch with forced draft. The unequal expansion is sure to cause injury to any fire brick under such circumstances, and very often the arch will break down before the engine reaches her train.

The higher the grade of brick, the better it will stand this kind of abuse, since the greater porosity enables the steam to escape more readily, but it will be much better to store the bricks in a warm place for a few days before installing, in order that they may become as dry as possible. In starting up a new stove or blast furnace, steel manufacturers take several days to get their furnaces up to heat, but they expect to get months or even years of service out of a lining.

Intelligent study of the subject will, without doubt, reduce expense in the use of fire brick arches.

GENERAL NEWS SECTION

NOTES.

It is understood that the strike of machinists on the Erie is broken, and that 150 of the old men have returned to work.

It is announced that the Burlington has made salary increases averaging 10 per cent. to employees over the entire system.

The Illinois 2-cent passenger bill was approved by Governor Deneen May 28, and makes a straight 2-cent limit for all railroads in the state.

The United States Express Company is reported to have signed a contract with the Detroit United Railway whereby it will handle all package express over its lines.

It is reported that the United States customs officers will make the examination of baggage crossing the Mexican border into the United States much more rigid than heretofore.

The San Pedro, Los Angeles & Salt Lake has been fined $1,000 in the United States Court for failing to make the required stops while shipping cattle. The company pleaded guilty to the indictment.

The Wisconsin senate has advanced the Nye bill providing that upper berths in sleeping cars must stay up unless taken, for benefit of lower berth occupants. It is said that this insures the bill's passage.

It is said that the National Association of Car Service Managers will enact a new rule that receivers must unload freight within 48 hours of the time the car is delivered, or pay $1 a day demurrage.

In accordance with an order issued by the Mississippi Railroad Commission, the principal lines doing business in that state have placed on sale interchangeable mileage books of 2,000 miles at a flat rate of $40.

The Santa Fe through its Statistician recently gave facts to the Interstate Commerce Commission in its hearing at Chicago on rates on live stock shipments showing that the live stock traffic is unremunerative.

Governor Hughes has signed the bill providing that all plans for barge and canal work must be submitted by the State Engineer to the Barge Canal Advisory Engineers Board before they go to the State Canal Board.

A general strike of machinists on the Louisville & Nashville was ordered May 29. It is said to affect 600 men. The machinists asked recognition of their union and a uniform scale of wages in each shop. No increase in pay was asked.

F. C. Donald, commissioner of the Central Passenger Association, has announced that second-class fares will be abolished between Pittsburg and all points in the association's territory, as well as through connecting gateways, effective July 1.

A brakeman on the New Haven road was standing on a car at New Rochelle, signaling, when his hand struck the overhead trolley wire. He is reported dying from the shock, and is said to be the third employee hurt in this way at New Rochelle.

The Philadelphia & Reading on June 3 announced a partial recession from its recent increase of suburban and commutation rates. The price of monthly tickets is reduced about half the increase of ten days ago. The increase had aroused violent public agitation and boycott.

The Massachusetts' Senate has concurred without amendment in the resolution adopted by the House condemning the management of the Boston & Albany by the New York Central. Attempts were made to force the Senate to pass a more radical resolution, but without success.

The Public Utilities Bill, establishing two Public Service Commissions in New York State, on June 4 passed the Assembly by a vote of 116 to 11 over the veto of the Mayor of New York City. The Senate re-passed it on June 5 by a vote of 39 to 8 and the bill now goes to the Governor.

President Mellen, of the New York, New Haven & Hartford, in speaking of an increase of wages on that road of $800,000 for the coming year, says: "I regret to say, so far as the organized labor item is concerned, that I am meeting a constantly decreased efficiency with every increase granted in wages."

The minimum weights which may be loaded in a car in order to get carload rates have recently been raised in Trunk Line territory. The minimum loading of the lighter iron and steel manufacturers has been advanced from 24,000 to 36,000 lbs. The minimum load of floor was advanced from 35,000 to 40,000 lbs.

Transcontinental lines have been notified by the Trunk Line Passenger Committee that its members will not join in rates and arrangements made for the annual meeting in Los Angeles next month of the National Educational Association, nor make any reduced rates whatever from their territory for that occasion.

The Neptune Line of steamers, owned by the United States Transportation Company, of which Stephenson Taylor is President and Robert C. Scholz Traffic Manager, commenced operations between New York and Fall River June 1, with the steamers Connecticut and Rhode Island, formerly of the Providence Line.

A number of large stockholders of the Atlantic Coast Line Railroad Co. have applied for an injunction to prevent the railroad from putting into effect the 2¼ cents per mile rate recently enacted as law in North Carolina, under the plea that if such a law became operative it would be confiscatory in character and therefore unconstitutional.

The Baltimore & Ohio announced May 28 that it would abandon four passenger trains on June 1 on account of loss incident to the 2-cent fare enforced by the Ohio legislature during its last session. Sections between Lorain and Akron and Akron and Youngstown will be affected. It is reported that other roads out of Cleveland will follow the example.

James Bingham, Attorney-General of Indiana, has given the Indiana Railroad Commission an opinion that the 2-cent passenger fare law of that state does not apply to interurban and other electric lines. The Attorney-General holds that the steam and interurban lines were regarded by the Legislature as two distinct classes of transportation companies.

An agreement has been reached between the city of Springfield, Mass., the New York, New Haven & Hartford and the Boston & Albany by which the city will be able to lay out a park on the east bank of the Connecticut river where the tracks of the New Haven road now lie. These are to be transferred to the west bank of the river and a new bridge built to bring them into the city.

After a conference with President Roosevelt, Commissioner Lane, of the Interstate Commerce Commission, announced June 4 that before July 1 legal proceedings will be instituted to compel E. H. Harriman to answer certain questions propounded to him by members of the commission at the recent hearing in New York when the merger of the Harriman lines was under investigation.

The New Haven road has bought from William Waldorf Astor a tract of ten acres on the north side of West Farms road, extending from Morris Park avenue to Van Nest street, the Bronx. Part of the tract will be used in connecting the tracks of the New York, Westchester & Boston Railway and the Harlem branch of the New Haven railroad, but a large part will be used as freight and car yards.

The Chicago, Cincinnati & Louisville, which has only recently begun running trains into Chicago at the Illinois Central station, has given notice that beginning July 1 its passenger rate between Chicago and Cincinnati will be $5.00, or $2.00 less than the present standard rate; but it will be only $1.00 less than other lines on the date named, owing to reductions worked by the new laws in Indiana, Ohio and Illinois. The Chicago, Cincinnati & Louisville is the shortest line between Cincinnati and Chicago.

After maintaining for 15 years the rate of 10 cents per mile for the transportation of passengers over the ten miles of road between Lake Placid, N. Y., and Saranac Lake, the Delaware & Hudson on June 3 placed in effect a schedule reducing the price of tickets to 3 cents per mile and making the regular Delaware & Hudson mileage at 2 cents per mile also good. The new schedule also reduces freight rates about one-half. Under its charter the Saranac & Lake Placid

road, which is controlled by the Delaware & Hudson Company, was authorized to charge a fare of $1 for transportation each way between Lake Placid and Saranac Lake.

It is understood that the general advance in freight rates to be made in the Central Freight Association territory, to become effective August 1, will average 6 per cent. It was originally planned to have the new rates take effect June 15, but at a recent conference it was decided to hold them over for a month and a half, as it will be impossible to file all the tariffs with the Interstate Commerce Commission for some time.

Complaint has been made by a citizen of St. Paul, Minn., to the Interstate Commerce Commission demanding a reduction by the Pullman Company and the railroads in the rates charged for berths in sleeping cars, and that upper berths be charged for at half the rate charged for lower berths. The rates complained of are on the Great Northern, the Northern Pacific and the Chicago, St. Paul, Minneapolis & Omaha (North-Western Line).

Judge Holt in the United States District Court handed down a decision June 4 overruling the demurrer interposed by the Great Northern Railway Company to indictments for rebating. Judge Holt holds that although the contract for rebating was made prior to the passage of the Elkins act, it was not finally consummated until after that act went into effect, and for that reason if proven would be sufficient to put the company on its defense at a final hearing.

Three additional suits attacking the constitutionality of the 2-cent fare law were filed at Philadelphia June 2, by counsel representing the Lehigh Valley, the Northern Central, and the Philadelphia, Baltimore & Washington. As in a suit recently instituted by the Pennsylvania Railroad Company, the county of Philadelphia is made defendant in the three suits. It is expected the principal contention to be made will be that the two-cent law is in violation of the federal constitution.

The New York State legislature has passed a bill providing that three brakemen must be employed on all freight trains of over 20 cars on all roads in the state which operate more than four freight trains daily. According to the representatives of the railroads who appeared at a hearing before the Governor, the enactment of such a law would cost the New York Central $500,000 and the Lackawanna $120,000 a year. The chief supporters of the bill are the railroad labor organizations.

The Pennsylvania is reported to have decided to abolish, on October 1, all commutation, workmen's and trip ticket rates in the state of Pennsylvania. This action is a direct result of the 2-cent fare law, which goes into effect on that date. The road has already asked for an injunction restraining the county of Philadelphia from enforcing the penalty prescribed for violation of the act. The company believes that this will be granted and the law thus made inoperative. If so, it will not abolish the low rates referred to.

A petition has been filed for a receiver for the Chicago-New York Air Line Railroad Company. An injunction is asked restraining the continuation of alleged practices which a former employee of the company named Nemoyer recently brought suit to stop. Nemoyer charged that President Alexander G. Miller was drawing a salary of $25,000 annually, and that Miller and his associates took 600 shares of stock in a construction company as payment for obtaining for the construction company the contract to build the road. The suit was dismissed, Nemoyer not being a stockholder.

Eight so-called "friendly suits" were filed in the United States District Court at St. Paul, May 31, against the Great Northern, the Northern Pacific, the Chicago, Milwaukee & St. Paul, the Chicago & North-Western, the Chicago, St. Paul, Minneapolis & Omaha, the Minneapolis & St. Louis, the "Soo," and the Chicago Great Western, to enjoin them from putting into effect the commodity rate recently ordered reduced by the Minnesota Railroad and Warehouse Commission. The state of Minnesota is made a party in the suits. Similar action was taken by the Rock Island on June 3.

Losses on New York Municipal Ferry.

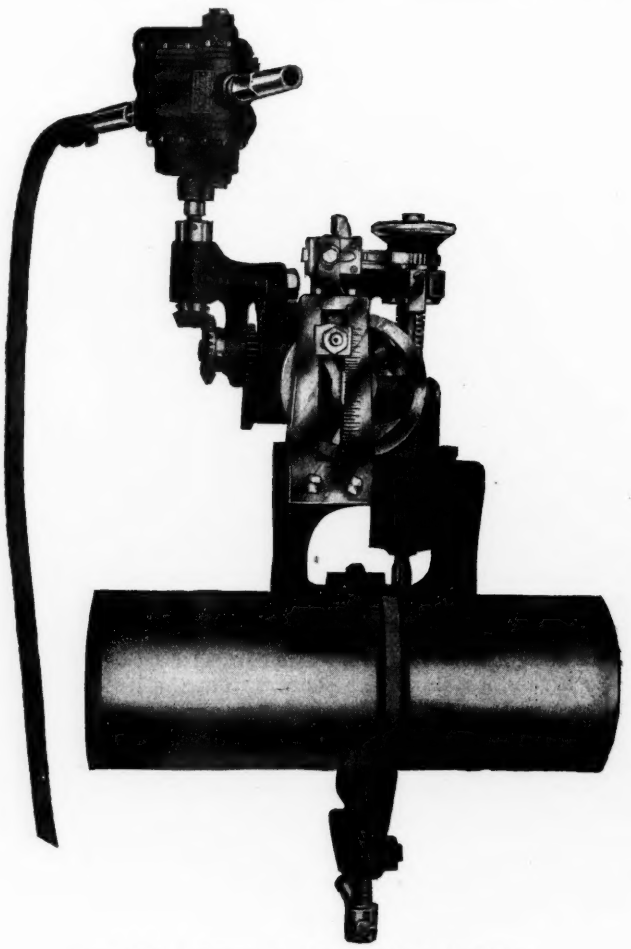
The Commissioner of the Department of Docks and Ferries of New York City estimates this year's loss on the municipal ferry between the Battery and Thirty-ninth street, Brooklyn, at $150,000, and the ferry from the Battery to Staten Island at $300,000. There is no fund from which to pay these losses, which must be met by the sale of bonds, yet, in the face of these facts, there has been a bill pending in the legislature to make the ferries free. As a commentary on the efficiency of municipal operation his further remarks are interesting:

> We cannot cut operating expenses. When the Staten Island ferry was taken over, we were told that New York City must have the finest boats on the bay. We have the finest in the world. We were told they must be speedy. We haven't the speed qualities of torpedo boats in these crafts, but we have cut the time down until we burn just four times as much fuel as any commercial body would in operating the boats the same number of trips. And then we have a matron on every boat and music.

The Ryerson Portable Automatic Key-Seating Machine.

A portable automatic key-seating machine—a new device just placed on the market—is shown in the accompanying illustration. The advantages of such a machine are evident to everyone acquainted with the difficulties in locating and cutting key-seats for eccentrics. Better and quicker work is done by the machine than is possible by other methods; it assures that eccentric and axle key-ways will correspond, a condition not always obtained when key-seats are cut before the wheels are pressed on. In repair work, where this condition exists and the old axle is retained, the portable key-seater can be used to recut the key-seat to agree with the eccentric, and thus avoid using an offset key.

The machine is designed to cut loose up to the driving box—working within 1 in. of it—and also its adjustment will permit any standard size key-way to be cut. The cutting is done within the base of the machine, producing a compact design and also permitting its use for eccentric cutting on axles where the distance between eccentrics is very limited. The base of the machine fitting over the axle is 8½ in. long. When used according to directions



Portable Automatic Key-Seating Machine.

it is claimed it will cut a 1 in. x ½ in. x 6 in. key-way in not more than 35 minutes.

The device may be driven by either air or electric motor, connection being made by a taper shank which is part of the machine. The speed should be between 300 and 450 r. p. m. Both the vertical and horizontal feed are entirely automatic, so that no attention is required after placing and starting the tool. The weight is approximately 100 lbs. Its use is not confined to driving axles, of course, serving equally well for key-seating shafting, etc. It is made by Joseph T. Ryerson & Son, Chicago.

Better Terminal Facilities at St. Louis.

Large plans are under way for improving the railroad terminal facilities at St. Louis. Already the bridge arbitraries have been abolished so that the rate to St. Louis is the same as to East St. Louis, Ill. The same rates apply on both sides of the Mississippi river. The Terminal Railroad Association of St. Louis has announced a general plan for improving the terminal facilities in the city at a cost of $7,000,000. The yard capacity will be increased from 1,600 cars to 8,000 cars. Three great freight centers are planned: one at Compton, Manchester, and Ranken avenues and Atlantic street, where there will be a 3,000-car yard; one on the site of the present roundhouse on 14th street in the Mill Creek valley, where there will be a yard with a capacity of 700 to 1,000

cars, and the other on the wharf between North Market and Ashley streets. Execution of the plans awaits the favorable action of the city council.

A Bureau for the Transportation of Explosives.

A "bureau for the safe transportation of explosives and other dangerous articles" has been formed under the auspices of the American Railway Association, with C. B. Dudley, Chemist of the Pennsylvania Railroad, as President; M. D. Maher, Vice-President in charge of operation of the Norfolk & Western, Vice-President, and W. F. Allen, Secretary of the American Railway Association, Secretary and Treasurer. The purpose of the organization is the proper and uniform enforcement of the regulations for transportation of explosives and other dangerous articles which may be placed under the jurisdiction of the bureau by the American Railway Association. Major Beverly W. Dunn, of the Ordnance Department, U. S. A., has been given leave of absence by the War Department and will on June 10 take charge of the bureau as Chief Inspector. The report, in the *Railroad Gazette* of May 31, that Major Dunn had been assigned to take part in preparing new rules for transportation of explosives was in error. The Chief Inspector will appoint local inspectors, who will be stationed in different parts of the country. Their duties will be to see that the regulations are complied with by manufacturers, shippers and railroads. The Chief Inspector shall also have authority to make examinations and tests of explosives, which shall be a necessary preliminary to the acceptance for transportation of any new explosives. There will be a testing laboratory at South Amboy, N. J. In case of a wreck caused by or resulting in an explosion on a railroad or in a manufacturer's establishment the local inspector will visit the scene as promptly as possible and make a report to the Chief Inspector of the facts in the case.

Traveling Boom Crane; Panama Railroad.

Union Pacific Free Passes in Nebraska.

Railroad companies in Nebraska now have to make a report showing the number of annual passes issued and outstanding in the state. The Union Pacific makes its return as 27, a tremendous reduction from the number in force before the passage of the Rate Law. This does not include employees' passes or "other passes issued under contract and not regarded as free transportation."

Cranes for the Panama Railroad.

The accompanying illustration shows one of a lot of eight cranes now being built by the Shaw Electric Crane Co., Muskegon, Mich., for the Panama Railroad. They are for use in handling miscellaneous freight at the Laboca wharf, which is the Pacific terminus of the railroad. The cranes were designed to meet the peculiar conditions existing at the wharf, among which may be mentioned a tidal variation of about 20 ft.

The boom, which is 80 ft. long, is shown in its working position, standing at an angle a little over 30 deg. from horizontal. It was required that the outer end should stand at sufficient height to carry loads over the decks of the largest vessels at high tide, while the other end must be low enough to project inside of the warehouse door. The boom may also be raised, carrying the outer end clear of all parts of vessels and withdrawing the inner end from the warehouse. With it in this position, vessels may be docked and the cranes placed opposite the hatchways in proper position for loading or discharging cargoes.

The main frame or tower is of steel construction, and stands 62 ft. above the track. There is a clear opening through it 10 ft. wide, in which the boom is suspended and through which the loads are carried. The base is so made that the crane can travel over freight piled to a height of 6 ft. between the tracks, so that goods may be trucked directly from under the crane to the warehouse. The space between the front of warehouse and edge of wharf was sufficient for a track of only 11 ft. gage. This, together with the necessary height and reach, made the question of stability a serious one. Although the weight of frame and machinery has been so disposed that the crane will be stable with a load 25 per cent. above normal capacity in the extreme position, clamps have been provided which are always in engagement with the rear rail, to prevent the crane from tipping if a load should become fouled on a hatchway or other part of the vessel.

The crane is mounted on six wheels, four under the front and two under the rear. Anticipating the possibility of uneven settling of the wooden wharf, the wheels are carried in equalizers, so arranged as to compensate for any probable irregularities of track without straining the structure. The machinery is placed in the base of the tower, adding to the stability of the crane, and giving easy access for inspection. For convenience in shipping and erecting, each set of machinery *is* mounted upon a separate frame, which is easily handled and put in place.

The crane has a regular working capacity of four tons, and a reach of 40 ft. from the center line between rails to the extreme outer position of load. The total height of hoist is 70 ft., and the speed hoisting with full load is 150 ft. per minute. The load can also be racked out and up at a speed of 150 ft. per minute. The other two movements, travel and boom hoist are relatively slow, being required only in setting the crane in position for service. The hoist is operated by a 65 h.p. motor, the rack motion by a 40 h.p., and the travel and boom hoist by 24 h.p. and 8 h.p. motors respectively. Automatic switches are provided to prevent overtravel in hoisting and racking out, also an overload switch for the hoist machinery. All movements are under the control of one operator, whose cab is so located as to give him the best view of his work. The crane weighs nearly 50 tons, and with the boom in the raised position it stands 90 ft. above the wharf.

The motors and controllers, as well as all structural work and machinery, are the product of the Shaw Electric Co.

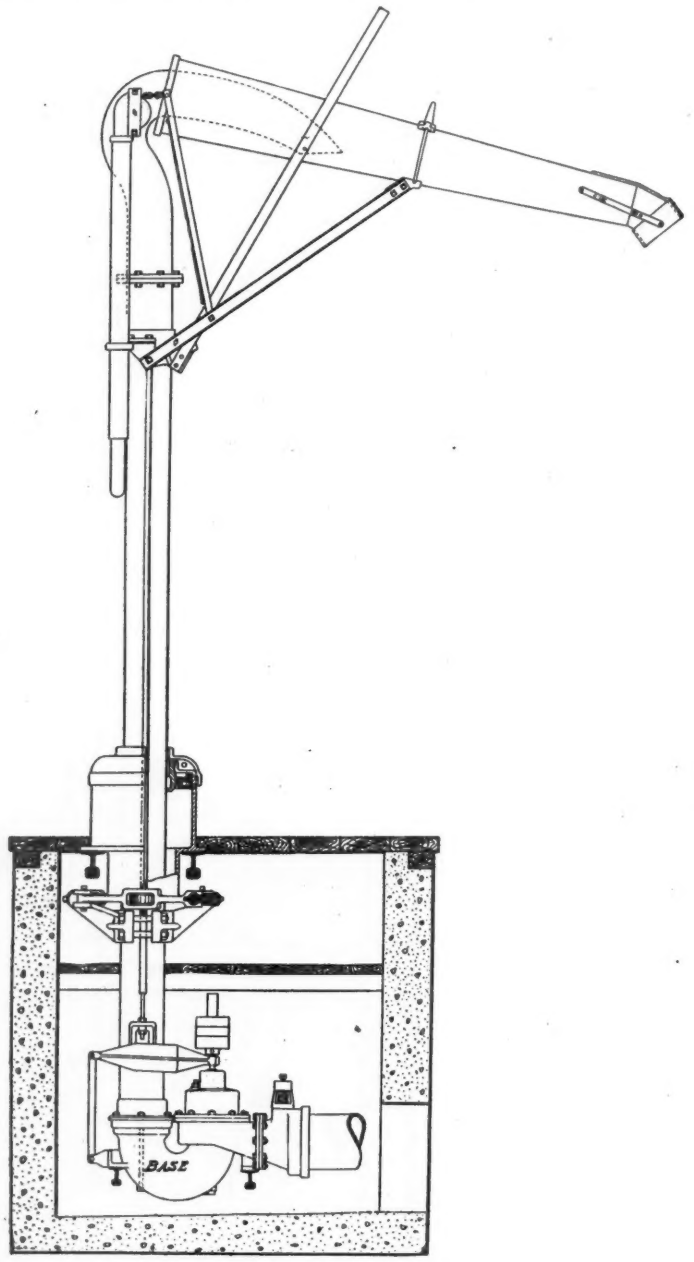
Switching Allowance Asked.

The Solvay Process Company at Solvay, N. Y., near Syracuse, has applied to the Interstate Commerce Commission to have the New York Central and the Lackawanna give it an allowance of $3 for each car handled by it in its own yards. The President of the company testified before Martin S. Decker, special examiner for the commission, that its shipments in and out in 1906 were 254,000 tons of soda products and 476,000 tons of coal and other shipments making up a total of about 865,000 tons. The company maintains its own yards and engines and does all of its own switch-

ing, having handled 64,000 cars last year. The company claims that the railroads should pay the expense of handling the cars in the yard. The railroads claim that their duty begins and ceases with receiving and delivering the cars from and to the company.

The Johnson Water Column.

The details of the Johnson railroad water column are illustrated herewith. It is a full-circle, one-man column designed to fit any locomotive tank of either high or low design, locks itself parallel to the tracks when not in use, works without danger to the operator, and is easily kept in order, it is claimed. The spout has a vertical range of 5 ft. where the track centers are 16 ft. or more. It is pivoted at a point midway between the high and low positions of



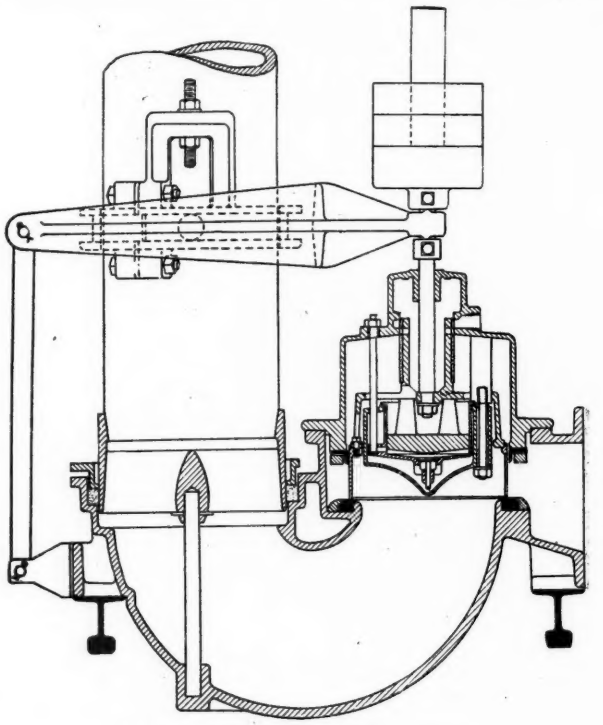
The Johnson Water Column.

the end of the spout, so that this end travels in an approximately vertical line, enabling it to enter the smaller manholes of locomotive tanks whether the tanks be of high or low design. The drip from the column will flow towards the end of the spout in any position, thereby avoiding the formation of ice in the spout. The flow of water from the goose-neck presses against the lower side of the spout, thus holding it in the manhole and overcoming any tendency of the spout to raise under high pressure.

The valve-controlling lever or bale is pivoted to the girder which supports the spout in such a manner that the lever moves with the spout without working the valve; this also brings the valve-controlling lever directly at the operator's hand when the spout has entered the manhole in either a high or a low tank. Forcing the valve-controlling lever down opens the valve and this force also operates to hold the spout down and in position.

The valve is designed to be always in balance. It is made of brass, works through a cup leather, and seats on a moulded rubber seat. It is opened manually by the operator and is closed by weights on the valve stem. The closing speed of the valve is governed by the escape of water from a brass dashpot, the size of the escape opening being varied by adjusting a screw from the outside of the bonnet. By removing the nuts which hold the bonnet to the base, the valve, dashpot and entire controlling mechanism can be lifted out vertically with the bonnet, making it easy to adjust and repair the valve outside of the pit and away from the wet and dirt.

The uptake pipe is standard wrought-iron pipe with threaded ends, and the side thrust is taken by roller bearings on finished surfaces. A pivot pin in the base carries the weight of the column, making the column self-contained and overcoming the necessity of adjusting the valve rods. The locking device is the usual spring, cam and roller mechanism, which is placed high in the pit where it is dry and open to inspection. The valve rods and connections



Valve for Johnson Water Column.

are outside the waterway where they can be inspected. The counterweights are of simple construction inclosed from the weather.

The Johnson column has been in use for about four years and 18 different roads have them in service. It is made and sold by Charles A. Stickney Co., St. Paul, Minn.

New Steamers for the International Mercantile Marine.

Nine new steamers to be built for the lines owned by the International Mercantile Marine Company are as follows:

(1) An express mail, passenger and cargo steamer for the North Atlantic trade which, the report states, in point of luxury and size will far surpass anything hitherto attempted.

(2) A passenger and cargo steamer, also for the North Atlantic trade.

(3) A passenger and cargo steamer for the Atlantic Transport Line, New York-London service.

(4 and 5) Two mail passenger and cargo steamers for the Dominion Line, Canadian service.

(6) A large passenger and cargo steamer for the London-Australian trade.

(7, 8 and 9) Three steamers for Leyland Line.

It is expected that these vessels, with the possible exception of the large fast steamer and the second steamer for the Canadian trade, will be in commission by the early part of 1909.

Owing to the disadvantage of operating under the American flag the company has sold two American-built steamers.

The earnings for the last three months of 1906 were seriously cut down by the congestion of the United States railroads, which in some instances resulted in absolute embargoes on all but perishable traffic to certain ports.

Supply Cars on the Canadian Pacific.

On the Canadian Pacific supply cars for distributing materials from the general storekeepers department have been in service for nearly 20 years. Early this year three new cars were put in commission on the lines east of the Great Lakes. These cars are 40 ft. 2 in. long, 8 ft. 2 in. wide and 8 ft. high, all inside measurements. Small supplies for stations and section houses are arranged on

shelves; oil tanks are provided with a capacity of 1,500 gallons of head light, 150 gallons of signal and 150 gallons of car oil. There is also sleeping accommodation for the man in charge of the car, who can when necessary get his own meals. The men in charge of the cars live in them from 22 to 26 days each month. The cars start out the first day of the month and run about 2,400 miles a month. The car which covers the Atlantic division handles 400 requisitions a month, the one on the Ontario division 600, and the one on the Lake Superior and Eastern divisions 550 each, so that on an average these three cars together handle about 1,500 requisitions a month.

A Chance for State Operation.

The Missouri Board of Equalization at a hearing in regard to the assessment of the Chester, Perryville & Ste. Genevieve, controlled by L. B. Hauck, received an offer from Mr. Hauck to have the state of Missouri operate the road for a year or two in order that the board might understand by practical experience the relation of taxation to expenses and profits. According to Mr. Hauck the state laws have removed every chance of making the road profitable. The Chester, Perryville & Ste. Genevieve runs from Cape Girardeau, Mo., on the Mississippi river, north to Westchester, which is opposite Chester, Ill., 63 miles, with a branch, the Saline Valley Railroad, from West Chester to Minith, 23 miles.

Rail Sales for 1908 Delivery.

Orders have been booked for 818,500 tons of rails for 1908 delivery, according to the *Wall Street Journal*. This total, which represents a gross business of over $23,000,000, compares with orders for about 1,000,000 tons booked a year ago for 1907 delivery. Of the current orders the United States Steel Corporation has about 350,000 tons and the Tennessee Coal & Iron Company 237,000 tons. The following table gives the rail orders for 1908 delivery placed since the books were opened:

	Tons.
Harriman lines to Tennessee Coal & Iron	157,500
Northern Pacific to United States Steel	65,000
Northern Pacific to Lackawanna Steel	*35,000
Rock Island to Tennessee Coal & Iron	10,000
Harriman lines to Bethlehem Steel	23,000
St. Paul to United States Steel	75,000
Southern Railway to Tennessee Coal & Iron	30,000
Burlington to United States Steel	45,000
Rock Island to United States Steel	25,000
Nickle Plate to United States Steel	5,00
Western road to United States Steel	10,000
Chicago & Eastern Illinois to United States Steel	5,000
Pennsylvania Railroad to various mills	147,000
Louisville & Nashville to Tennessee Coal & Iron	40,000
Savannah, Augusta & Northern to U. S. Steel	*46,000
Canadian roads	30,000
Miscellaneous	70,000
Total	$18,500

*For this and next year's delivery.

Through Routes and Through Rates.

The Interstate Commerce Commission, in an opinion rendered June 5 by Commissioner Lane, announces a construction of the Rate Law which holds that most of the railroads in the United States are united as parts of through routes over which through rates exist even where no joint rate has been established. The decision deals with the movement of 10,000,000 lbs. of sugar held in storage at Omaha which was brought into that city from the West before the existing tariff out of Omaha and to the East went into effect. The question raised was whether or not the Chicago, Burlington & Quincy might allow sugar stored in Omaha to go forward under a tariff put in effect after the sugar had arrived at Omaha.

Commissioner Lane, dealing with this question, says:

Sugar which moved from Longmont, Sterling, Brush, Fort Morgan and Loveland prior to the going into effect of this tariff cannot be moved out of Omaha under its provisions and on the rate fixed therein. A proportional rate is a through rate, and can be applied only to traffic moving thereunder from point of origin to destination. At the time the sugar moved from the originating points named, this tariff was not in effect and the local rate paid into Omaha cannot be treated as an advance payment upon a proportional rate which was not in effect at the time of origin of movement.

There can be but one through rate in effect between any two points at a given time, and this rate may be a point rate or a combination of rates applicable on through business. Where no joint through rate is in effect, combination through rate over a through route may be made up of any rates applicable on through transportation—the sum of the locals, or a poroportional rate in and a local rate out, or two or more proportionals, or any other lawfully established rates which may be joined together to make a rate over the through route; but such combination through rate must be treated as a unit from the date of original shipment to the date of arrival at destination and the rate applied must be the combination of rates which exists upon the date of original shipment. Tariffs cannot be given a retroactive effect; they cannot be made to apply to conditions other than those existing upon the date when such tariffs become effective. A combination through rate is as binding, definite, and absolute as a joint through rate; and all of the conditions, regulations, and privileges obtaining as to any factor in such combination rate for through shipment at the time of initial shipment upon such combination through rate must be adhered to and cannot be varied as to that shipment during the period of transportation of such shipment to its final destination. A local or proportional rate "in" cannot be absorbed, diminished, or affected by any "out" rate not in effect at the time when the traffic moved upon such local or poroportional rate.

A further question decided in the same case is as to the rate that should govern over a through route when a through rate charged is made up of the sum of the locals. Commissioner Lane holds that the rate that should be applied is a combination through rate made up of the sum of the locals or other lawfully established rates applicable on through business at the time when the shipment originates, as follows:

There may be through routes without joint rates. A joint rate is simply a through rate every part of which has been made by express agreement between the carriers making the through route. The joint rate is a rate over a through route; but it is not the only through rate recognized by the act and the decisions.

Among the important amendments made in 1906 to the interstate commerce act was that which makes it the duty of every carrier subject to the act "to establish through routes and just and reasonable rates applicable thereto" (Section 1.) It is not necessary here to attempt to discover the full force of these words. Their significance is not to be grasped without consideration of the latter portion of the act (section 6), which expressly recognizes the possibility of a through route without a joint rate, and which, after directing the publication and filing of local rates and of joint rates, provides for still other rates in the following language:

"If no joint rate over the through route has been established, the several carriers in such through route shall file, print, and keep open to public inspection, as aforesaid, the separately established rates, fares, and charges applied to the through transportation."

The reasons for this rule are at least two: (1) The policy of the law that every route and every service shall have a published rate equally known and equally available to all patrons of the carriers, and (2) the policy of the law that carriers not otherwise subject to the act shall be, when participating in interstate business, subject to the act to regulate commerce.

A through route is a continuous line of railroad formed by an arrangement, express or implied, between connecting carriers. It must have a rate for every service; and, as the route is a new unit—one line formed of two or more connecting lines—so its rate for every service is a unit, even though it be divided between the several carriers arranging themselves into the through route. Through carriage implies a through rate. This is equally true whether the through rate be published as a whole by the joint action of the connecting carriers, or, in the absence of a joint arrangement, be published in portions by the several carriers. The route being one, a contract for a service over it is a contract for a single service, all the terms of which must be fixed at one and the same time; that is, at the time of the making of the contract for the service. The rate is either a joint through rate made by arrangement by the parties to the through route, or it is a combination through rate consisting of the separately established rates, fares, and charges applied to the through transportation. This sum, however, is a single rate for a single service.

In answering the question as to the existence of a through route all the incidents and circumstances of the shipment must be taken into account. Carriers arranging for a through route, and also for a joint rate, must give notice to the world of such arrangement by publication. Carriers forming through routes without joint rates, however, may publish and file only the separately established rates, fares, and charges applied to the through transportation. As a matter of fact most, if not all, carriers subject to the act use their local rates as through rates where no joint rate is established. It is therefore evident that such incidents as the billing, the collection and division of charges, the use of a proportional rate to or from junction points or basing points, and other local incidents of the transaction may properly be depended upon for guidance as to the existence of a through route. A through bill of lading as to the carriers recognizing it has been held by the Supreme Court to be conclusive evidence of the existence of a through route.

Demands of Railroad Employees in Great Britain.

Resolutions recently passed by some 50,000 railroad employees assembled in London contain the following demands, compliance with which it is estimated would raise the expenses of English railroads by $37,500,000 and reduce the average dividend rate from 3 to 1.7 per cent. These resolutions are as follows:

1. An 8 or 10-hour day, according to class.
2. Minimum of 9 hours' rest before duty.
3. Overtime at a time and a quarter minimum.
4. Sunday duty to be regarded as distinct from the ordinary week's work, and to be paid for at a minimum of time and a half.
5. An immediate advance of 50 cents a week to all grades who do not receive 8-hour day.
6. All grades to be paid in London a minimum of 75 cents a week above the wages paid in the country.
7. Abolition of working only one man in motor cars on electric railways.

Joint Rail and Automobile Rates.

The traffic department of the Tonopah & Tidewater Railroad has issued a circular showing its present arrangements for freight transportation at the northern end of its line. On May 25 the company began operating regular automobile service between Zabriskie, now the last rail station, which is 91 miles north of Ludlow on the Santa Fe, to Greenwater, Cal., the center of a new copper district. The automobile trip takes about 2½ hours. One-way and round-trip tickets, covering railroad and automobile trips, are on sale at principal Santa Fe ticket offices. A commercial agency has

been established in Greenwater. Hand baggage only will be carried on the automobiles; other baggage must be handled by freight teams between Zabriskie and Greenwater.

Two-Cent Fares in Kansas.

Nebraska has passed a 2-cent fare law and through it the Kansas Railroad Commission hopes to obtain a reduction of passenger fares in Kansas to that level, although a 2-cent fare law was rejected at the recent session of the Legislature. If the railroads do not contest the Nebraska law the board will be asked to issue an order reducing rates to 2 cents a mile in Kansas on the ground that the railroads in Nebraska, by failing to contest the law, admit that a 2-cent rate is remunerative. On the other hand, if the railroads do contest the Nebraska law, and the law is upheld, a reduction will be ordered in Kansas on the ground that a 2-cent a mile rate has been held by the courts remunerative in Nebraska and, therefore, that it must be remunerative in Kansas.

Natural Snow Fences.

The Pennsylvania Railroad through its forestry bureau has begun planting low-growing shrubs a few feet apart along the sides of the tracks through the Allegheny mountains at points where snow drifts are accustomed to form on the track in winter. These will take the place of wooden rail fences.

Liquor Shipments in Texas.

A new Texas law fixes a tax of $5,000 on express companies for each office in the state through which c.o.d. shipments of liquor are handled. The Texas railroads have since refused to accept shipments of liquor where there were any charges to be collected at destination, fearing that they would be liable to the tax as doing an express business. The Attorney-General has now ruled that this traffic is permissible by the railroads, so that hereafter Texas lines will accept "shippers order notify" shipments of liquor. Agents, however, are strictly prohibited from collecting from the consignee or remitting to the shipper the price of any liquor.

Municipal Car Line in San Francisco.

The city of San Francisco is to take over the Geary Street Railway at a cost of $750,000. The road is to be converted from a cable to an underground trolley system.

One-Cent Rate for Legislators.

The New Hampshire legislature last winter proposed to pass a law providing that the Boston & Maine should carry about 1,000 state employees free. A substitute measure which was passed provided that the Governor should contract for the transportation of certain state officials. An arrangement has now been made with the Boston & Maine by which about 400 state officials will be carried for 1 cent a mile on mileage books, good only in the state of New Hampshire over the Boston & Maine and the Maine Central.

Broken Rails in Canada.

The Canadian Railway Commission, on account of the increasing number of wrecks directly due to broken rails, has begun an investigation of rail breakages. Since November 15 there have been six such wrecks resulting in loss of life. The Chief Engineer of the commission has called on the railroads to submit their specifications for rails now on order. The commission is considering a system of government inspection either of the manufacture of rails or of the finished product.

Opening of Brooklyn Subway Postponed.

The Counsel and the Chief Engineer of the Rapid Transit Commission have recommended that the construction company which is building the Manhattan-Brooklyn subway, including the tunnel from the Battery under the East river to Brooklyn, be allowed until May 1, 1908, to finish the line. The original contract called for completion of the road from the Battery to the borough hall in Brooklyn by September 1, 1907.

Railroad Commission for Pennsylvania.

The first railroad commission to be established in the state of Pennsylvania is created by a law which was signed by the Governor on May 31. There are to be three commissioners, appointed by the Governor, one of whom is to be a lawyer. They are to be paid $8,000 each. The commission has power over steam and electric railroads, express, telegraph and telephone companies, not only to summon and examine witnesses and investigate complaints, but to inspect all books, papers, leases and contracts. The law goes into effect January 1, 1908.

New York Central Reconstruction Contract Cancelled.

The contract of the O'Rourke Engineering-Construction Company for the excavation and construction of the Grand Central terminal, now a little more than one-third finished, has been cancelled, because the railroad found it impossible to allow the work to proceed as fast as was desired by the construction company. In consequence of the interruption of the work by the movement of trains the O'Rourke company lost heavily. The railroad company has bought the contractor's plant and will organize its own working staff and carry out the work as rapidly as possible.

A Secretary of Transportation.

President W. A. Garrett, of the Seaboard Air Line, in a despatch from Savannah, Ga., is quoted as follows:

President Roosevelt is badly in need of a Secretary of Transportation. The time has come for such a Cabinet office. This official should have great power over matters of transportation, should see that the roads give good service and point out to the public the real situation as to the ability of roads to perform service at given rates. He should be broad-minded and one in whom the public has confidence. He could warn the railroads when they are exceeding their rights and should caution the public when it is pushing the roads too hard.

What the country needs now is service, and how is service to be maintained or improved? Certainly not by cutting down the revenues of the roads.

TRADE CATALOGUES.

Irrigated Lands in Montana.—The Chicago, Burlington & Quincy has issued a folder containing information about irrigated lands in the valley of the Yellowstone river near Billings, Mont., which is likely to persuade anyone who reads it and wishes to get close to the soil to move at once to this particular part of Burlington and Northern Pacific territory. The profits and cost of raising sugar beets, alfalfa and potatoes, the three principal crops of the district, as well as fruit, vegetables, poultry and cattle, are recited in some detail and the characteristics of the region and of Billings as a city described. The principal irrigated lands in this district are those owned by the Billings Land & Irrigation Company, the Columbus Land & Water Company and the Cove Ditch Company. Photographs of several of the farms and farmhouses are given and of vegetables raised on irrigated farms "six months from the sage brush."

"Around the Circle" in Colorado.—The Denver & Rio Grande has issued a remarkably attractive illustrated booklet under this title describing the "Circle" trip from Denver through Colorado Springs, the Royal Gorge, Marshall Pass and Montrose to Ridgway, thence via the Rio Grande Southern to Durango, through La Veta Pass and back to Denver, with an alternate stage trip over part of the route. This trip of 1,000 miles through the Rockies covers a succession of mountain scenery which is a revelation to anyone unfamiliar with Colorado and its attractions. The road crosses the continental divide at Marshall Pass at an elevation of 10,860 ft., and at Cumbres, Colo., in the Toltec gorge district near the southern boundary of the state, reaches nearly as great an elevation.

Electric Hoisting Machinery.—The Lidgerwood Manufacturing Co., New York, is distributing a pamphlet illustrating and describing several types of electric hoists driven by General Electric 250 to 500-volt direct-current motors. These hoists are built with single and double drums, and in sizes from 1½ to 50 h.p. The pamphlet gives sizes, diameters, weights and capacity. The electric mast hoist, which is a new type, has two drums, and is driven by a 20-h.p., 250-volt motor. It is mounted on the side of the derrick mast and is furnished with swinging gear.

Rail Specifications.—The American Bureau of Inspection and Tests, consulting and supervising engineers, Chicago, has published a pamphlet giving specifications for new and relaying rails of various grades, and other information interesting to buyers and railroad engineers. On the back of the pamphlet is printed a convenient table showing the material needed for one mile of single-track road. This table shows the number of cross ties needed for different lengths of rail, tons of rail of various weights, and splices, bolts and spikes of different sizes required.

Air Compressors.—Catalogue No. 58 of the Sullivan Machinery Co., Chicago, is entitled "Modern Practice in Air Compression." It has 112 pages and is well illustrated. It gives general data on the use of compressed air, and fully describes different types of compressors, including types of Sullivan straight-line air compressors,

Duplex air compressors, Corliss air compressors, and high-pressure air compressors, as well as air reservoirs, air reheaters, rock drills, etc., made by the company.

Dominion Atlantic Railway.—The passenger department of this road has issued a pamphlet entitled "Summer Homes in Nova Scotia." It is attractively illustrated and gives the names of places in Nova Scotia which can be reached via the Dominion Atlantic. The attractions of each town are listed, and hotels and boarding houses, with the rates they charge, are given.

Machine Tools.—Catalogue No. 4 of the Pratt & Whitney Co., Hartford, Conn., is a full catalogue of this company's products, which include taps and dies, bolt and pipe threaders, drills, lathe tools, boiler punchers etc. The catalogue illustrates, describes and gives sizes and price list of a great variety of these and similar tools.

Interurban Equipment.—Bulletin No. 1,058 of the Allis-Chalmers Co., Milwaukee, describes the Winona Interurban, the first section of which, from Warsaw, Ind., to Goshen was recently finished. All of the machinery and electrical equipment in the power-house sub-station and cars were furnished by the Allis-Chalmers Co.

Insulators.—A folder which is being distributed by the H. W. Johns-Manville Co., New York, is devoted to Keystone hair insulators. This material consists of cleansed and chemically treated cattle hair, packed between layers of building paper. It can be used for all purposes to which sheathing papers are applicable.

Bolt and Rod Heating Furnaces.—The Rockwell Engineering Co., New York, is distributing two folders describing furnaces for heating rods and for heating bolts. The folders give diameters and weights of a number of styles of each furnace. The fuel used is either oil or gas.

Staybolts.—The Falls Hollow Staybolt Co., Cuyahoga Falls, O., is distributing circulars calling attention to tests of staybolts made by a committee of the Master Mechanics' Association, and using these results as a text to point out advantages of the hollow staybolt.

Valves.—The Crane Co., Chicago, is distributing a pamphlet briefly describing and illustrating some of its more important valves, fittings and special appliances. It is designed to call attention to apparatus more fully described in the company's complete catalogue.

Michigan Central.—The passenger department is distributing a folder describing the attractions of Topinabee, Mich., a summer resort on the west shore of Mullet Lake. The photographs reproduced are charming and the literature is convincing.

Graphite.—The Joseph Dixon Crucible Co., Jersey City, N. J., has published a 43-page report made by Prof. W. F. M. Goss, of Purdue University, on the series of tests of graphite made by him several years ago.

Manufacturing and Business.

Dodge & Day, engineers and constructors, Philadelphia, have opened an office at 115 Broadway, New York, in charge of Robert T. Lozier.

D. J. Carson, who has been in charge of the New York office of the American Brake-Shoe & Foundry Company, Mahwah, N. J., for the past two years, has been appointed manager of the American Malleables Company.

The American File Sharpener Co., New York, will exhibit at Atlantic City, during the Master Car Builders' and Master Mechanics' conventions, a file sharpening machine, and will give daily demonstrations of its operation.

The Power Specialty Company, 111 Broadway, New York, reports recent sales of 120 Foster superheaters, aggregating 42,000 h.p. These superheaters are to be installed in B. & W., Stirling, Edge Moor, Heine, Franklin, Atlas and other boilers, including a number of return tubular boilers.

The Northern Engineering Works, Detroit, Mich., recently shipped to the Denver & Rio Grande a second three-motor, electric, traveling, 15-ton, Northern crane of special construction, for house use. The crane is operated by alternating current motors, and is designed to run on an overhead curved track.

A quarterly dividend of 1 per cent. on the $30,000,000 common stock of the American Car & Foundry Company has been declared, payable July 1. This declaration raises the annual rate from 2 per cent. to 4 per cent., quarterly dividends of one-half of 1 per cent. each having been paid in January and April, 1907. No dividends were paid in 1906 and 1905, and previous annual dividend rates were as follows: 1904, 1 per cent.; 1903, 4 per cent.; 1902, 2 per cent.; 1901, 2 per cent., and 1900, 1 per cent.

A. W. Wheatley, Assistant Superintendent of Motive Power and Machinery of the Union Pacific, has been appointed General Inspector of the American Locomotive Company, with office at Schenectady, N. Y. Mr. Wheatley is 35 years old; he came from England 15 years ago, and began railroad work on the Northern Pacific as a machinist. He worked his way up until he was made General Master Mechanic, and then went to the Chicago, Rock Island & Pacific as Superintendent of the East Moline shops. He was appointed Assistant Superintendent of Motive Power and Machinery of the Union Pacific in the spring of 1906. As General Inspector of the American Locomotive Company, Mr. Wheatley will report to the Vice-President in charge of manufacturing, and he will oversee shop practice at the different works.

Iron and Steel.

The Chicago & North-Western has ordered 4,000 tons of rails; the Wisconsin Central, 6,000 tons; the Pennsylvania, 3,000 tons, and the Rock Island, Arkansas & Louisiana, 7,000 tons. The Atchison, Topeka & Santa Fe is in the market for about 50,000 tons.

The Wisconsin Bridge Company has an order for 3,500 tons of steel for the Clinton (Iowa) bridge from the Chicago & North-Western. The Toledo-Massillon Bridge Company, Toledo, Ohio, has orders for 4,700 tons for two bascule bridges over the Chicago river. The Missouri Bridge & Iron Co., St. Louis, Mo., has a contract for 1,000 tons of steel for the Eighteenth street bridge, St. Louis. It is estimated that between 150,000 and 175,000 tons of structural steel has been ordered in May, which is the largest amount for any month since the first of the year.

The Seaboard Air Line, it is said, has ordered 11,000 tons of rails from an eastern mill, and the Northern Pacific 35,000 tons from the Lackawanna Steel Company for this year's delivery; the Southern has ordered 300,000 tons from the Tennessee Coal & Iron Company for delivery next year, and is also negotiating for 10,000 tons of Bessemer rails. The Chesapeake & Ohio is in the market for 11,000 tons. The Harriman inquiry for 25,000 tons of Bessemer rails has been withdrawn.

OBITUARY NOTICES.

Archibald MacArthur, President of MacArthur Bros. Co., contractors, died on June 2 at his home at Riverside, N. Y. Mr. MacArthur was 73 years old, and had been for many years at the head of the firm founded by his father.

Francis L. Clark, Consulting Engineer for the Westinghouse Air-Brake Company, died in Los Angeles on May 26 of paralysis and heart disease. Mr. Clark was 65 years old. He had been chief draftsman and engineer of the Westinghouse Air Brake Company until about six months ago, when he had an attack of paralysis and went to California; he was then made a Consulting Engineer.

P. J. McGovern, Chairman of the Southern Classification Committee, died at El Paso, Tex., on May 30 from pulmonary trouble. Mr. McGovern had gone to Texas several months ago on account of his illness. He was born in Cincinnati, Ohio, in 1856, and began railroad work as a clerk in a local freight office of the Louisville & Nashville in 1882. He worked his way up until appointed Assistant General Freight Agent in 1890, and two years later went to the Richmond & Danville, now part of the Southern, as clerk to the Traffic Manager. In the fall of that year he was made Assistant Commissioner of the Southern Railway & Steamship Association and the Southern States Freight Association. In 1896 he returned to the Southern Railway as chief clerk in the rate department of the general freight office, and after three years took the position he held at the time of his death.

John A. Walker, Vice-President and Treasurer of the Joseph Dixon Crucible Company, died recently at his home in Jersey City, N. J. Mr. Walker was born in New York in 1837. He prepared for college but went at once into business instead. He served in the Civil War and in 1867 went to Joseph Dixon & Co. The next year, when the present company was formed, he was made Secretary; later he assumed also many of the duties of Manager and was also made Treasurer. In 1891 he was elected to the office he held at the time of his death. For some years the general management of the company has been largely in his hands. Mr. Walker was of Scotch descent. He was keen and critical, and his business career shows his faculty for looking ahead and preparing for emergencies. His broad tastes and diverse interests are evidenced in the many offices he held outside of his main duties. He was Vice-President

of the Colonial Life Insurance Company, and a director of several trust companies; President of the Children's Friend Society, and a member of the Chamber of Commerce of New York and of the Board of Trade of Jersey City. He was a member of several Jersey City clubs, and also of the National Geographical Society, the Society for Psychical Research and an Associate Member of the American Institute of Mining Engineers. He was formerly on the Jersey City Board of Education and Trustee of the Jersey City Public Library and of other city institutions.

ELECTIONS AND APPOINTMENTS.

Executive, Financial and Legal Officers.

Buffalo & Susquehanna.—Charles W. Goodyear, who was recently elected President of the Buffalo & Susquehanna, was born on October 15, 1846, at Cortland, N. Y. He was educated at Cortland Academy. He studied law and was admitted to the bar in 1871, and later was made District Attorney of Erie County, N. Y. He practiced law until 1887, and then was elected Second Vice-President of the Buffalo & Susquehanna Railroad. When the present company, the Buffalo & Susquehanna Railway Company, was organized, he was made First Vice-President. He has also been Vice-President of the New Orleans Great Northern, which was organized last year, and he has now been elected President of this company also.

C. W. Goodyear.

Chicago & Alton.—James B. Forgan has resigned as a Director.

Delaware & Hudson.—W. H. Williams, who was recently appointed Assistant to the President, was born at Athens, Ohio, on June 25, 1874, and has been in railroad service since 1890. He began as assistant cashier in the local freight office at Toledo on the Pennsylvania Lines West, but resigned to take a business college course. In the fall of 1891 he went to the Pittsburg & Lake Erie, and in February, 1892, returned to the Pennsylvania Company, and became a stenographer in the office of the Superintendent of Telegraph at Pittsburg, later being appointed to a similar position in the office of the General Manager. In January, 1901, he became chief clerk to the Fourth Vice-President, and six months afterward was appointed Assistant Secretary of the Baltimore & Ohio. In September, 1902, he was appointed Assistant to the General Manager of the Baltimore & Ohio, and in 1904 was appointed Superintendent of Freight Transportation of the St. Louis & San Francisco. In July, 1905, he left railroad work to become Traffic Manager of the Merchants' and Manufacturers' Association of Pittsburg. He was later made Traffic Manager of the Pittsburg Chamber of Commerce, where he remained until his recent appointment to the Delaware & Hudson.

W. H. Williams.

See Napiersville Junction.

Napiersville Junction.—L. F. Loree, President of the Delaware & Hudson, has been elected also President of the Napiersville Junction, succeeding W. C. Witherbee, resigned. George F. Hartt has been elected Vice-President and Assistant Treasurer. C. A. Walker, Treasurer of the Delaware & Hudson, has been elected also Treasurer of the Napiersville Junction, and L. J. Beique has been elected Secretary. The road, which has just been opened, is an extension of the Delaware & Hudson from Rouse's Point, N. Y., northwest to St. Constant, Que.

New Orleans & North-Eastern.—D. E. Curran, Vice-President and General Manager, has been elected President of this road and of the Alabama & Vicksburg and the Vicksburg, Shreveport & Pacific, succeeding C. C. Harvey, resigned.

New Orleans Great Northern.—C. W. Goodyear, Vice-President, has been elected President, succeeding F. H. Goodyear, deceased. M. E. Olmstead, General Counsel, has been elected Second Vice-President.

Norfolk & Western.—W. G. MacDowell, Vice-President, has been elected First Vice-President. N. D. Maher, General Manager, has been elected also a Vice-President; T. S. Davant, Freight Traffic Manager, has been elected Vice-President and Traffic Manager. These elections are effective July 1.

Rock Island Company.—A. S. Greig, Assistant to the President of the St. Louis & San Francisco, has been appointed Assistant to the Chairman of the Executive Committee of the Rock Island Company.

St. Louis & San Francisco.—See Rock Island Company.

Southern Pacific.—Charles H. Reddington has been elected Assistant Treasurer, succeeding A. K. Vandeventer.

Traffic Officers.

Chicago, Burlington & Quincy.—E. H. Smith has been appointed General Agent at Cleveland, Ohio, succeeding M. F. McMillan, resigned on account of ill health.

Manistee & North-Eastern.—F. A. Mitchell, General Freight and Passenger Agent, has been appointed to the new office of Traffic Manager. Dennis Riely, commercial agent of the Ann Arbor at Toledo, Ohio, succeeds Mr. Mitchell, with office at Manistee, Mich.

St. Joseph & Grand Island.—F. O. Hatch, formerly General Agent of the Chicago Great Western at San Francisco, Cal., has been appointed General Agent of the St. Joseph & Grand Island at San Francisco.

Tehuantepec National.—See Vera Cruz & Pacific.

Vera Cruz & Pacific.—G. J. Dwan, Assistant General Freight and Passenger Agent, has resigned to go to the Tehuantepec National.

Operating Officers.

Denver & Rio Grande.—W. S. Martin, General Manager of the Mexican International, has been appointed Assistant General Manager of the Denver & Rio Grande.

Hidalgo & Northeastern.—See National Lines of Mexico.

Interoceanic of Mexico.—See National Lines of Mexico.

Lake Shore & Michigan Southern.—See Michigan Central.

Mexican International.—See National Lines of Mexico.

Michigan Central.—S. W. Brown, Assistant General Superintendent of the Lake Shore & Michigan Southern, has been appointed General Superintendent of the Michigan Central, succeeding H. C. Nutt, resigned to go to the Northern Pacific. Mr. Brown was born in Illinois in 1858; he began railroad work in 1872 as night operator on the Chicago, Burlington & Quincy. He was transferred to the general offices a few years later and, after serving as chief despatcher on the St. Louis division, resigned in 1886. He was out of railroad work until 1901, when he was made Trainmaster of the Western division of the Lake Shore & Michigan Southern. In 1903 he was appointed Assistant Superintendent of that division and also of the Indiana, Illinois & Iowa. In the spring of 1905 he was made Superintendent of the Western division, and in the fall of that year was transferred to the Eastern division. A year later he was appointed

S. W. Brown.

Assistant General Superintendent, which position he leaves to go to the Michigan Central.

Missouri, Kansas & Texas of Texas.—C. H. Scott, Acting Superintendent of the Shreveport and Mineola divisions and the McKinney branch, has been appointed Superintendent of the Fort Worth, Dallas, Denton and Henrietta divisions, and the Sherman, Bonham and Cleburne branches, with office at Denison, Tex., succeeding R. J. Sullivan, resigned.

Missouri Pacific.—A. J. Alexander, Superintendent of the Arkansas division, has been appointed Superintendent of the Eastern division, with office at Sedalia, Mo., succeeding H. G. Clark, promoted. J. Cannon, Superintendent of the Missouri division, succeeds Mr. Alexander, with office at Little Rock, Ark. J. W. Dean, Superintendent of the Central division, succeeds Mr. Cannon, with office at De Soto, Mo. J. M. Walsh, Superintendent of the Northern Kansas division, succeeds Mr. Dean, with office at Van Buren, Ark. W. E. Brooks, Inspector of Passenger Service, succeeds Mr. Walsh, with office at Atchison, Kan.

L. B. McGuire, Acting Trainmaster at Nevada, Mo., has been appointed Trainmaster at that place.

National Lines of Mexico.—The authority of A. Clark, General Manager of the National Railroad of Mexico and of the Mexican International, has been extended over the Interoceanic of Mexico and the Hidalgo & Northeastern. H. M. Taylor, General Manager of the Interoceanic of Mexico, has been appointed Assistant General Manager of the four roads.

National Railroad of Mexico.—See National Lines of Mexico.

New York Central & Hudson River.—C. L. Bardo has been appointed Superintendent of the Electric division, with office at New York.

Southern.—C. G. Walker, Agent at East St. Louis, Ill., has been appointed Superintendent of the Louisville division of the St. Louis-Louisville Lines, with office at Louisville, Ky., succeeding B. C. Milner, resigned to go into other business at Atlanta, Ga. J. F. Sheridan, Assistant Superintendent of the St. Louis division, has been appointed Superintendent of Terminals at East St. Louis, and his former office has been abolished.

Trinity & Brazos Valley.—John J. Flynn, Superintendent of the Memphis division of the Yazoo & Mississippi Valley, has been appointed Superintendent of the Trinity & Brazos Valley, with office at Teague, Tex., succeeding J. M. Lee, resigned. W. A. Allison, Trainmaster of the Memphis division of the Yazoo & Mississippi Valley, has been appointed Superintendent of Telegraph of the Trinity & Brazos Valley, with office at Teague, Tex.

Union Pacific.—A. W. Wheatley, Assistant Superintendent of Motive Power and Machinery, has resigned to go to the American Locomotive Company as General Inspector, with office at Schenectady, N. Y.

Yazoo & Mississippi Valley.—See Trinity & Brazos Valley.

Engineering and Rolling Stock Officers.

Erie.—William Schlafge, General Master Mechanic, has been appointed Assistant Mechanical Superintendent, and his former office has been abolished. George O. Hammond, Mechanical Superintendent, has been appointed Assistant to the Mechanical Superintendent. E. G. Chenoweth, draftsman, succeeds Mr. Hammond. The offices of all are at Meadville, Pa.

Missouri, Kansas & Texas.—H. J. Tierney has been appointed to the new office of Mechanical Engineer, with office at Parsons, Kan.

New York, New Haven & Hartford.—M. C. Hamilton has been appointed Engineer of Maintenance of Way, with office at New Haven, Conn., succeeding W. J. Black, transferred.

Northern Pacific.—A. C. Terrell, Division Engineer at Spokane, Wash., has, at his own request, been transferred to his former position of Assistant Engineer at Trout Creek, Wash.

Pennsylvania.—C. L. McIlvaine, Master Mechanic at Camden, N. J., has been appointed Assistant Engineer of Motive Power of the Buffalo & Allegheny Valley division, with office at Buffalo, N. Y., succeeding S. G. Thomson, transferred to the General Manager's office.

Western Maryland.—David Holtz, Master of Machinery, with office at Union Bridge, Md., has resigned after 30 years' service, and the office has been abolished.

Purchasing Agents.

Central New England.—See New York, New Haven & Hartford.

New York, New Haven & Hartford.—A. E. Mitchell, Expert and Engineer of Tests, has been appointed Manager of Purchases and Supplies of this company and of the Central New England. He will perform his former duties as well as those of Purchasing Agent heretofore performed by E. L. Pollock, resigned to go to the Rock Island. Mr. Mitchell graduated as Mechanical Engineer from the Maine State College in 1875. He served for ten months as an apprentice in the Baldwin Locomotive Works, and then, in 1877, began railroad work in the Altoona shops of the Pennsylvania. Two years later he was transferred to the test department, and in 1880 was made Assistant Engineer of Signals. After spending a year in the Yale & Towne Manufacturing Company, he went to the New York & New England, now part of the New York, New Haven & Hartford. In 1884 he again left railroad work and spent two years in mechanical engineering work for different companies. He then went to the motive power department of the New York, Lake Erie & Western, now the Erie, and in 1887 was made Engineer of Signals. He was appointed Engineer of Tests in 1889, and in 1890 Mechanical Engineer of the Erie and of the Chicago & Erie; he was made Superintendent of Motive Power in 1892. In 1901 he was appointed Assistant Superintendent of Motive Power of the Chicago, Milwaukee & St. Paul, and a year later went to the Northern Pacific as Superintendent of Motive Power. In 1904 he was appointed Superintendent of Motive Power of the Lehigh Valley, where he remained until last spring. He was later employed by the New York, New Haven & Hartford to inventory and appraise the value of the road's motive power and rolling stock; this work was followed by his appointment as Engineer of Tests.

A. E. Mitchell.

LOCOMOTIVE BUILDING.

Swift & Co., Chicago, have ordered three 30-ton saddle tank locomotives from the Davenport Locomotive Works.

Fantauzzi & Company, owners of the Lafayette sugar plantation, Porto Rico, have ordered a locomotive from the Baldwin Locomotive Works.

The Mexico, Santa Fe & Perry Traction Co., as reported in the *Railroad Gazette* of May 31, is in the market for one electric locomotive. S. L. Robison, President and General Manager, Mexico, Mo.

The Nevada Northern, as reported in the *Railroad Gazette* of May 24, has ordered two consolidation (2-8-0) locomotives from the American Locomotive Co., for August delivery. The specifications are as follows:

General Dimensions.

Type of locomotive	Consolidation
Weight, total	333,000 lbs.
Weight on drivers	168,000 "
Diameter of drivers	51 in.
Cylinders	21 in. x 30 in.
Boiler, type	Straight top
" working steam pressure	180 lbs.
" number of tubes	380
" material of tubes	Charcoal iron
" diameter of tubes	2 in.
" length of tubes	14 ft. 9 in.
Firebox, length	108 in.
" width	69 "
" material	Open hearth
" grate area	51.7 sq. ft.
Heating surface, total	3,084.0 "
Tank capacity	7,500 gals.
Coal capacity	12 tons

Special Equipment.

Air-brakes	Westinghouse-American
Couplers	Tower

The Colorado Midland, as reported in the *Railroad Gazette* of May 17, has ordered six simple consolidation (2-8-0) locomotives from the Baldwin Locomotive Works, for October delivery. The specifications are as follows:

General Dimensions.

Type of locomotive	Consolidation
Weight, total	193,000 lbs.
Weight on drivers	175,000 "
Diameter of drivers	52 in.
Cylinders	22 in. x 28 in.
Boiler, type	Straight top
" working steam pressure	200 lbs.
" number of tubes	413
" diameter of tubes	2 in.
" length of tubes	15 ft.
Firebox, length	108 in.
Firebox, width	66 "
Tank capacity	7,000 gals.
Coal capacity	About 15 tons

Special Equipment.

Air brakes	Westinghouse
Boiler lagging	Magnesia
Brake-beams	Marden
Brake-shoes	Perfecto
Couplers	Climax
Injector	Monitor
Journal bearings	Ajax
Piston rod packings	United States
Valve rod packings	United States
Safety valve	Crosby
Sanding devices	Leach
Sight-feed lubricators	Nathan
Tires, driving wheel	Midvale

CAR BUILDING.

Bond Brothers, Bond, Md., have ordered some passenger cars.

The Prescott & North-Western is said to have ordered 25 flat cars from the Danville Car Company.

The O. F. Jordan Company, Chicago, has ordered five flat cars from the Hicks Locomotive & Car Works.

The United Verde & Pacific has ordered one combination coach from the American Car & Foundry Co.

The Chicago, Lake Shore & Eastern has ordered 2,600 freight cars from the American Car & Foundry Co.

The Mexican Railway is in the market for six chair cars, six first-class coaches and six third-class coaches.

The American Car & Foundry Co. has recently booked orders for one beef car, 105 tank cars, 50 cane cars and 18 logging cars.

The La Croze Tramways Co., Buenos Ayres, has ordered some single and double truck cars from the J. G. Brill Company.

The Chicago, Burlington & Quincy has ordered 2,000 40-ft. wooden box cars of 80,000 lbs. capacity from the Pullman Co.

The Solvay Process Company has ordered 10 steel double bottom hopper coal cars of 50 tons capacity from the Standard Steel Car Company.

The Stewart Sugar Company (formerly the Silveria, Cuba, Sugar Company) has ordered fifty 100,000-lb. cars from the American Car & Foundry Co.

The J. M. Guffey Petroleum Company has ordered 100 steel-underframe tank cars of 80,000 lbs. capacity from the American Car & Foundry Company.

The Cedar Rapids & Iowa City Railway & Light Company is figuring on 25 stock cars, five flat cars and five box cars, all of 60,000 lbs. capacity.

The Arms Palace Car Company, Chicago, as reported in the *Railroad Gazette* of May 17, has ordered ten express horse cars from the Pullman Company.

The Bolivia Railway has ordered 10 passenger coaches from the American Car & Foundry Co., to be built at Wilmington, Del., as reported in the *Railroad Gazette* of March 1.

The Detroit & Toledo Construction Company, Harvey, Ill., successors to the Chicago & Southern Traction Co., has ordered three flat cars and one ballast car from the Hicks Locomotive & Car Works.

The Elgin, Joliet & Eastern, as reported in the *Railroad Gazette* of May 3, has ordered 1,350 steel underframe side dump gondola cars, 1,000 steel side dump coke cars and 250 steel drop bottom gondola cars from the American Car & Foundry Co.

The Aurora, Elgin & Chicago, as reported in the *Railroad Gazette* of May 24, has ordered two standard cars of 80,000 lbs. capacity from the Hicks Locomotive & Car Works. These cars will be 52 ft. 10½ in. long, 8 ft. 8 in. wide and 13 ft. 8 in. high, over all.

The Mexican National Sugar Refining Company has ordered a number of cars for its Cordoba, Vera Cruz, plantation railroad, as reported in the *Railroad Gazette* of March 15. The Eastwick Engineering Co., 32 Broadway, New York, represents the sugar company.

The Mexico, Santa Fe & Perry Traction Co., as reported in the *Railroad Gazette* of May 31, is in the market for six passenger cars, one party car, one express car, one work car and one line car. The passenger cars will be 52 ft. long from bumper to bumper, and weigh from 30 to 32 tons. S. L. Robison, President and General Manager, Mexico, Mo.

The Kanawha & West Virginia has ordered ten 36-ft. box cars of 60,000 lbs. capacity from the Hicks Locomotive & Car Works. The special equipment includes:

Couplers	Tower
Door fastenings	Security
Draft rigging	Miner
Roofs	Excelsior Car Roofing Co.

The Colorado Midland has ordered 100 coal cars of 80,000 lbs. capacity from the Western Steel Car & Foundry Co., instead of from the Pressed Steel Car Co., as reported in the *Railroad Gazette* of May 17. These cars are for July delivery, and will measure 36 ft. long, 9 ft. wide and 4 ft. high, inside measurements. The special equipment includes:

Brakes	Westinghouse
Couplers	Climax
Draft rigging	McCord
Journal boxes	McCord

The Nevada Northern, as reported in the *Railroad Gazette* of May 24, has ordered 50 side dump gondola cars of 100,000 lbs. capacity from the National Dump Car Co,, for August delivery. These cars will weigh 36,000 lbs., and measure 22 ft. long, 10 ft. wide and 9 ft. 4½ in. high, inside measurements. The special equipment includes:

Brake-beams	Simplex
Brakes	Westinghouse
Couplers	Climax
Draft rigging	Republic.

The Tonopah & Goldfield, as reported in the *Railroad Gazette* of April 12, has ordered six cabooses of 30,000 lbs. capacity from the Pullman Company for June delivery. These cabooses will measure 18 ft. 4 in. long, 9 ft. wide and 6 ft. 3 in. high, inside measurements. The special equipment includes:

Axles	Pullman
Brake-beams	Pullman
Brake-shoes	Christie
Couplers	Climax
Door fastenings	Yale
Springs	Pittsburg Spring & Manufacturing Co.
Wheels	Griffin

The Atlanta, Birmingham & Atlantic has ordered 500 40-ft. box cars and 300 40-ft. flat cars, both of 60,000 lbs. capacity, from the American Car & Foundry Company, and 900 40-ft. coal cars of 80,000 lbs. capacity and 30 40-ft. cabooses from the South Atlantic Car & Manufacturing Company; deliveries are to be made at the rate of 10 to 15 a day, beginning August 1, 1907. The special equipment for all cars includes:

Bolsters	Bettendorf
Brakes	Westinghouse
Couplers	Major
Draft rigging	Miner
Journal boxes	Bettendorf (Integral)
Roofs, box cars and cabooses	Hutchins outside
Trucks, box and flat cars	Bettendorf frames
Trucks, coal cars and cabooses	Bettendorf

The Atchison, Topeka & Santa Fe, as reported in the *Railroad Gazette* of May 24, has ordered 250 tank cars of 10,000 gallons capacity from the Pressed Steel Car Company for August, 1907, delivery. The tanks will be built by the Hamler Boiler & Tanks Works. These cars will measure 35 ft. 7 in. long, inside measurements, and 38 ft. 1¾ in. long, 9 ft. 6 in. wide and 12 ft. $9^1/_{16}$ in. high, over all. The special equipment includes:

Bolsters	American Steel Foundries
Brake-beams	Kewanee
Brakes	Westinghouse
Brasses	Hewitt
Couplers	R. E. Janney
Draft rigging	Westinghouse
Journal boxes	Franklin
Springs	Simplex
Trucks	Barber
Wheels	Griffin

RAILROAD STRUCTURES.

Evansville, Ind.—The Evansville & Terre Haute has given a contract for its new passenger station to cost $95,000.

Kansas City, Kan.—The Chicago, Rock Island & Pacific, it is said, will put up 12 shop buildings here as soon as an ordinance is passed by the city vacating certain streets.

Madison, Ohio.—Local reports state that the Lake Shore & Michigan Southern will put up a new freight and passenger station here to cost $50,000.

New Orleans, La.—The Louisville & Nashville, it is said, will enlarge its freight yards at Gentilly at a cost of $150,000.

Toronto, Ont.—Dickson Bros. has the contract for a steel bridge over Spanish river, to cost $20,000.

The Grand Trunk, it is said, has decided to build an overhead bridge across its tracks at Sunnyside Park.

Vera Cruz, Mex.—Excavation work for the new union terminal buildings at this place has been started under the direction of Rodolfo Wiessner. The main work will not be started until the fall. The project calls for an expenditure of $8,000,000, and the construction of larger terminals than any now in existence in Mexico. The proposed passenger station and office building is to cost $1,000,000 Mexican currency.

Wilkesbarre, Pa.—It is expected that work will soon be started on the new East End bridge. The structure is to cost about $100,000, of which $25,000 is to be paid by the city and $20,000 each by the Central of New Jersey, the Delaware & Hudson and the Lehigh Valley Railroads.

Winnipeg, Man.—Contract for the additions to the Canadian Pacific shops here has been let to McDiarmid Bros., at $150,000.

RAILROAD CONSTRUCTION.

New Incorporations, Surveys, Etc.

BOSTWICK.—An officer writes that this company has finished its road and it is now in operation from Bostwick, Ga., southeast to Apalachee, on the Central of Georgia, six miles. John Bostwick, President, and W. B. Thomas, Chief Engineer, Bostwick, Ga.

CHICAGO, OTTAWA & PEORIA.—Incorporated in Illinois, with $50,000 capital, to build from Chicago, southwest to Peoria, 150 miles, with a branch from Ottawa west to Princeton, 35 miles. The incorporators include: H. E. Chubbock, of Ottawa, and W. A. Carnahan, C. Zilly, C. A. Wright and G. Mattis, of Champaign.

DELAWARE & HUDSON.—The Napierville Junction has been opened for traffic from Rouse's Point, N. Y., via Lacombe and Napiersville to St. Constant, Que., where connection is made with the Grand Trunk and the Canadian Pacific. (March 15, p. 383.)

DUE WEST.—An officer writes that a grading contract has been given to W. O. Willard, also to Gilliam Bros., and to O. Sullivan for ties. The line is building from Donalds, S. C., in Abbeville county on the Southern, south to Due West, 4½ miles. Track laying is to be started shortly. R. S. Galloway, President, and T. C. Anderson, Chief Engineer, Due West, S. C.

GLENFIELD & WESTERN.—An officer writes that this company, which now operates a line from Glenfield, N. Y., where connection is made with the Rome, Watertown & Ogdensburg division of the New York Central & Hudson River, to Page, 16½ miles, has finished grading on an extension of 2½ miles to Monteola. The work is being done by the company's forces.

GRAND TRUNK PACIFIC.—Construction work on the line from Winnipeg to Edmonton is being pushed with all possible speed. Owing to the late winter, work has been delayed for nearly two months and extra forces of men will be put on to make up for lost time. The section of 275 miles from Portage la Prairie, Man., west to Touchwood Hills is being built by the Macdonald-McMillan Construction Co., of Winnipeg; the next section of 150 miles from Touchwood Hills to Saskatoon, Sask., by the Canadian White Co., and the section from Saskatoon to Edmonton, 315 miles, is being built by Foley Bros., Larsen & Co. These contractors are experiencing considerable difficulty in securing labor and are offering unusual inducements to workingmen. The line west from Edmonton to the Pacific is being surveyed, the route having been located through the mountains. There will not be any construction work done on this section for some time.

GULF LINE.—This company, recently incorporated in Georgia, with office at Atlanta, is planning to build an extension of the Flint River & Gulf from Hawkinsville, Ga., to Bainbridge, 130 miles, and eventually to a gulf port about 100 miles additional.

HORNELL & DANSVILLE.—The New York State Board of Railroad Commissioners has granted a certificate of necessity to this company to build a line from Burns, in Allegheny County, N. Y., north to Danville, Livingston County, 10 miles. Connection is to be made with the Erie at Burns and with the Dansville & Mount Morris at Dansville. The company has a capital of $100,000.

ITHACA-OWEGO TRACTION.—Incorporated in New York with $200,000 capital to build an electric line from Ithaca, N. Y., southeast to Owego, 50 miles. C. W. Munson and J. F. Delaney, of Chicago, are directors.

LAKE ERIE, FREMONT & SOUTHERN (ELECTRIC).—Incorporated in Ohio to build a line from the Toledo, Port Clinton & Lakeside, three miles southwest of Oak Harbor, south through Ottawa, Sandusky and Seneca counties to Tiffin, about 30 miles. A franchise has been secured by the company for a belt line at Fremont, in Sandusky County. H. F. Shunk, T. Schmitt, A. E. Klauser and G. W. Luckey, of Toledo, are incorporators.

LONG ISLAND.—This company is planning to shortly start work on the elimination of grade crossings at North highway, Claypit road and at St. Andrews road in the Shinnecock Hills. The highways are to pass under the tracks at these points. Plans are also under way to eliminate grade crossings at Old West road, Westbury and New York avenue in Huntington.

NAPIERVILLE JUNCTION.—See Delaware & Hudson.

NEW YORK ROADS.—The Salisbury Steel & Iron Company will build a five-mile line to connect its works with the terminus of a spur of the New York Central at Dolgeville, N. Y.

NEW YORK SUBWAYS.—The Rapid Transit Board of New York City has voted to build the Fourth avenue subway in Brooklyn. The projected route is from Chrystie street, in the Borough of Manhattan over the new Manhattan bridge, thence by a four-track subway through the Flatbush extension and Flatbush avenue to Fourth avenue, from which point a two-track subway will run to Coney Island; also one to Fort Hamilton. The plans have also been passed by the Board of Estimates and bids are to be asked for the work in about two weeks. On July 1, when the Rapid Transit Board goes out of existence, the Public Utilities Commission will take charge of the work.

NORTHERN EMPIRE.—Application has been made by a company under this name for incorporation to build a line from a point on the international boundary east of Cardeston, Alb., north through Lethbridge and Fort McMurray, thence northwest passing through Fort Vermillion to a point on the boundary line between British Columbia and Yukon, thence northwest through that territory to the Alaska boundary. Also to build a branch following the north bank of the North Saskatchewan river to Edmonton, Alb.

OHIO & PACIFIC BELT.—An officer writes that this company has been organized to build a belt line from Lowellville, Ohio, northeast to Struthers, to connect the works of the Ohio Iron & Steel Company with the works of the Youngstown Sheet & Tube Company. No work on the line is to be done this summer. Robert Bentley, President, and C. L. Mackey, Engineer, Youngstown.

OKLAHOMA EMPIRE.—Incorporated in Oklahoma with $15,000,000 capital to build a line from a point in Osage reservation, Ind. T., southwest to the western boundary of Greer County, Okla. The incorporators include: T. Eggleston, P. F. Slaton, H. S. Christian and R. F. Pascholl, of Granite.

PENN EASTERN.—Incorporated in Pennsylvania with $150,000 capital to build a line from a point in Pike County, Pa., near Matamoras, on the Delaware river, southwest paralleling that river via Dingman's Ferry, 14 miles. The directors include: William B. Hilliard, of Milford, Pa.; F. W. Cross, C. G. Wood, F. H. Baker and J. W. Stickney.

QUICKSAND-HYDEN.—Organized to build a line from Quicksand, Ky., south through rich coal and timber fields in Lewis County to Hyden, 13 miles. J. W. Gilley, R. C. Lewis and Gilmer Lewis, Quicksand, Ky., are interested. Surveys are to be made at once.

RIO GRANDE, SIERRA MADRE & PACIFIC.—At a recent meeting, it is reported, this company decided to at once spend $15,000,000 building an extension under the name of the Sierra Madre & Pacific from its southern terminus south 100 miles; also a branch from its line at Guzman west to Cananea. (March 15, p. 396.)

ROCKWOOD & BAKERSVILLE.—Incorporated in Pennsylvania with $90,000 capital to build a line from Rockwood, Somerset County, Pa., north to Bakersville, nine miles. C. F. Hood, President, Connellsville; J. S. Braddock, F. L. Brown, S. F. Hood, J. L. Schiek and E. H. Werner, are directors.

ST. LOUIS, BROWNSVILLE & MEXICO.—Arrangements, it is said, are being made by this company to start work on its proposed extension from Algoa, Tex., north to Houston. The extension from Algoa east to Galveston will probably not be built, and trackage rights between these two points may be secured over the Gulf, Colorado & Santa Fe.

ST. LOUIS SOUTHWESTERN.—Local reports state that this company is making surveys for a branch from a point on the main line near Illmo, Mo., north to Cape Girardeau, Mo., seven miles.

ST. MARYS & KINGLAND.—This company, building a line from St. Marys, Ga., northwest to Kingland, 10 miles, has grading finished, and will start track-laying about June 15. S. T. Hanks, Colesburg, is the contractor. L. Johnson, President and General Manager, St. Marys.

SIERRA MADRE & PACIFIC.—See Rio Grande, Sierra Madre & Pacific.

SOUTHERN PACIFIC.—Grading has been finished on the extension of Morgan's Louisiana & Texas from Lafayette, La., which is 145 miles west of New Orleans, east to the west bank of the Mississippi river opposite Baton Rouge, 53 miles. The work includes 12 miles of trestles to be filled in with earth over the Atchafalaya swamp. There is also to be a bridge over the Atchafalaya river 450 ft. long. A ferry service will be put in use from the west bank of the Mississippi to Baton Rouge.

SPRINGFIELD, BEARDSTOWN & QUINCY (ELECTRIC).—Incorporated in Illinois with $25,000 capital and office at Springfield. The company proposes to build an electric line from Springfield, Ill., northwest to Petersburg, thence west via Chandlerville and Beardstown to Quincy, about 100 miles.

SUSQUEHANNA & NEW YORK.—A contract is reported let to Edward Whalen, of Towanda, and work has been started at Marsh Hill, Pa., on a branch south via Newberry Junction to Williamsport, about 18 miles. Yards are to be added at Newberry Junction and at Marsh Hill.

UNION PACIFIC.—The second main track construction on this road this year in addition to the 175 miles in operation between Omaha and Green River, Wyoming, will include about 200 miles

additional. The Lane Cut-Off between South Omaha and Lane, Nebraska, necessitates 3,000,000 cu. yds. of excavation. The cuts include one a mile long with an extreme depth of 87 ft. Two-thirds of the grading is finished, and all the work is to be finished this year. The cut-off saves nearly nine miles over the old main line by way of South Omaha and Gilmore. From Lane to Valley double tracking was finished late last year. About 50 miles more, from Valley to Benton, is to be finished this year. The next sections to be double tracked are between Silver Creek and Lockwood, 38 miles; Alda to Buda, Neb., 29 miles, and Rawlins to Wamsutter, Wyo., 41 miles.

Vandalia.—This company is laying a second track from Knightsville, Ind., west to East Yard at Terre Haute, about 14 miles, and the grades along the line are being reduced to a maximum of 0.04 per cent. Nine reinforced concrete subways will carry highways under the tracks and two roads will be carried over the tracks on reinforced concrete bridges, eliminating 11 grade crossings. There will also be eight reinforced concrete culverts. This work entails about 700,000 yards of earthwork and 15,000 yards of masonry. It is expected that the line will be in operation this month. About a mile of second track is also being constructed between the west end of the Wabash river bridge, Terre Haute, to Macksville. On this improvement no masonry is needed. The earthwork will aggregate approximately 200,000 cubic yards, all embankment, and will be finished within a few weeks. A new double-track line is being built from Brazil to Seelyville, eight miles. The line now in use will be maintained as a third track when the new line is finished. In the old line there are nine curves aggregating 2.77 miles in length, and 208 deg. of central angle. On the new line there will be three curves, aggregating 0.66 miles in length, and a total angle of only 29 deg.

Woodville.—An officer writes that this company is building with its own men a line from Woodville, Fla., on the Seaboard Air Line, west to Spring Hill, on the Georgia, Florida & Alabama, 10 miles. Track laid for six miles. Thomas M. Hall, Chief Engineer, Woodville.

RAILROAD CORPORATION NEWS.

Boston & Maine.—Governor Guild of Massachusetts on June 4 wrote to President Mellen of the New York, New Haven & Hartford, asking that the facts of the reported merger be given to the responsible representatives of the Commonwealth. On the same date President Mellen replied that interests identified with the New Haven have acquired a large stock interest in the Boston & Maine and have agreed to acquire the rest of the stock in exchange for New Haven stock, share for share. The Boston & Maine stock is not to be held by the New York, New Haven & Hartford directly. The purchase was made to prevent the sale of the Boston & Maine to another company. If the consolidation is carried out, through service is to be established through the Connecticut valley and via Worcester through the Merrimac valley, and the terminals of the two roads in Boston are to be unified. The letter closes with a statement that the power of the Commonwealth to control and regulate is unquestionable, and the New Haven hopes to be recognized as Massachusetts' most efficient public servant. Governor Guild, in a message to the legislature on June 5, recommends that at the present session it reaffirm by statute the determination of the Commonwealth to control the operation of her railroads. It is understood that the Boston & Maine stock will be held by the New England Steamship Company, a new company recently organized to take over the operation of the steamship properties of the New Haven. The purchaser referred to in Mr. Mellen's letter is probably either the Grand Trunk or the Canadian Pacific.

Chicago & Alton.—The Directors, on June 4, declared the regular semi-annual dividend of 2 per cent on the $19,544,000 preferred stock. It is understood that this decision was reached only after prolonged discussion, the Harriman interests favoring the payment but the Rock Island interests preferring to apply the surplus to improvements. The Comptroller estimates that the road will earn during the current fiscal year 4.11 per cent. on the $19,542,800 common stock, after the payment of the dividend on the preferred.

Chicago Junction Railway.—See Indiana Harbor Railroad.

Connecticut Railway & Lighting Company.—F. J. Lisman & Co., New York, are offering $75 a share for $200,000 4 per cent. guaranteed common stock of this company. The property is leased to the Consolidated Railway for 999 years from December 19, 1906, and the lease is guaranteed by the New York, New Haven & Hartford. The rental and a cash fund deposited with the Colonial Trust Company is enough to pay perpetual dividends on the stock. (Dec. 28, 1906, p. 184.)

Consolidated Railway (N. Y., N. H. & H. Electric Lines).—See New York, New Haven & Hartford; also Connecticut Railway & Lighting Company.

Erie.—Gross earnings for April were $4,671,405, an increase of $1,154,143; net earnings, $1,451,024, an increase of $559,202.

Erie & Jersey.—This company has borrowed $3,000,000 for 3½ years, at 6 per cent., secured by $4,000,000 Erie & Jersey bonds as collateral. The company is building the Guymard cut-off for the Erie from Mount Hope, N. Y., to Highland Mills, 42 miles.

Illinois Central.—L. C. Fritch, Assistant to the President, is quoted as saying that the Illinois 2-cent fare law will reduce the Illinois Central passenger earnings $800,000 a year, and that the state will accordingly lose $50,000 a year of the tax it levies on earnings.

Indiana Harbor (Belt).—It is reported that New York Central interests have bought control of the Chicago Junction Railway and that it is intended to merge the company with the Indiana Harbor. The Chicago Junction operates a belt line around Chicago from Whiting, Ind., to Franklin Park, Ill., with branches to the Union Stock Yards and other industries.

Louisville & Nashville.—The syndicate headed by J. P. Morgan & Co., which in February, 1906, bought $10,000,000 4 per cent. Atlanta, Knoxville & Cincinnati division, 50-year bonds of 1905, has been dissolved. The syndicate bought the bonds at from 98 to 98½, and only 16 per cent. has been sold to the public. They were quoted on June 4 at 89⅞ bid and 91 asked.

Louisville Railway Company.—This company, which owns all the street railways in Louisville, Ky., and nearly all of whose $6,000,000 common and $2,500,000 preferred stock is owned by the Louisville Traction Company, has issued $500,000 collateral trust, 6 per cent. notes redeemable at any time from 1908 to 1910. The proceeds are to pay for rolling stock and extensions.

Mobile & Ohio.—Gross earnings for April were $976,360, an increase of $178,409; net earnings $253,220, an increase of $49,359. Net earnings for the first ten months of the present fiscal year were $2,789,884, an increase of $266,157.

New England Navigation Company.—See New York, New Haven & Hartford.

New England Steamship Company.—See Boston & Maine.

New York, New Haven & Hartford.—The stockholders on May 31 approved the merger with this company of the Consolidated Railway. It is understood that the Consolidated recently bought the New England Navigation Company for $20,000,000 and issued in this connection $20,000,000 additional stock, making the total outstanding stock of the Consolidated Railway Company $30,000,000. This stock has all been owned by the New York, New Haven & Hartford, which recently increased its capital stock from $100,000,000 to $130,000,000. The new stock was exchanged for the Consolidated Railway stock, and, though technically outstanding, is now held in the treasury of the railroad company, and if sold to the public the proceeds can be used for some other purpose. See Connecticut Railway & Lighting Company; also Boston & Maine.

New York, Ontario & Western.—This company has borrowed about $1,000,000 on one-year notes.

This company's statement of April earnings shows a striking contrast with the earnings of April, 1906, when the coal strike was tying up its coal traffic. The earnings in the current year are also largely increased over those of the same period of the normal year of 1905. Gross earnings for April, 1907, were $707,503, as compared with $343,017 in 1906, and $590,554 in 1905; net earnings, $200,922, as compared with a deficit of $29,710 in 1906, and earnings of $190,412 in 1905.

Philadelphia & Reading.—This company has made an equipment trust agreement covering $5,000,000 4½ per cent. equipment trust notes. They will be issued in blocks as the equipment is delivered.

Southern.—Gross earnings for April were $4,768,457, an increase of $412,395; net earnings $718,202, an increase of $125,222, the operating ratio having been reduced from 86.4 per cent. to 84.9 per cent. The net earnings for the period since July 1 still show a decrease. The net earnings for the ten months of the current fiscal year were $9,912,155, a decrease of $2,208,622.

Toledo Railway & Terminal.—This property was sold under foreclosure for $2,000,000, the upset price, on May 28, to the protective committee representing the holders of the $3,500,000 first mortgage, 4½ per cent. bonds. The company went into receivership in January, 1906, as a result of the C., H. & D. and Pere Marquette receiverships.

Union Pacific.—Gross earnings for April were $6,287,988, an increase of $948,182; net earnings, $2,261,323, an increase of $119,440.